DOCUMENT RESUME

ED 385 673 CE 068 513

TITLE	Automatic Transmission/Transaxle Specialist. Instructor Manual and Student Workbook. Automotive Service Series.
INSTITUTION	Oklahoma State Dept. of Vocational and Technical Education, Stillwater. Curriculum and Instructional Materials Center.
PUB DATE	95
NOTE	703p.; For other documents in the series, see ED 310 278 and CE 068 514-519. Approximately half of the document is printed on pastel colored stock.
AVAILABLE FROM	Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, OK 74074-4364 (instructional package, 1 teacher and 10 student editions, order no. TI2233: $150; student edition, TI3233: $9).
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF04 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Auto Mechanics; Behavioral Objectives; Instructional Materials; Integrated Curriculum; Job Skills; Learning Activities; Motor Vehicles; Postsecondary Education; Power Technology; Secondary Education; State Curriculum Guides; Student Evaluation; *Trade and Industrial Education
IDENTIFIERS	*Transaxles (Automotive); *Transmissions (Automotive)

ABSTRACT

This curriculum guide for transmission/transaxle specialist is one in a series of automotive service speciality publications that is based on the National Institute of Automotive Service Excellence task lists. The curriculum contains nine units. Each unit of instruction includes some or all of the following components: objective sheet, instructor's guide, information sheet, instructional supplement, assignment sheet, job sheet (and skill test record), written test, answers (to assignment sheets and written test), transparency masters, learning activity package (LAP) sheet, handouts, and other required media. These components are organized within three packages. The instructor's manual includes the following: a curriculum and duty/task crosswalk; basic skills matrix; one set per unit of instructor's guide, answers, and test code sheets; and instructional supplement (one set for all basic skills enablers appearing in the book). The instructor's resource package contains one set per unit of LAP sheet, transparency masters, and written test; handouts; and other required media. The student workbook includes objective sheets, information sheets, assignment sheets, and job sheets. The nine units cover the following topics: introduction to automatic transmissions and transaxles; servicing hydraulic system components; servicing rear-wheel drive transmissions; servicing torque converter and oil pump; servicing gear train/gearsets; servicing friction units and cooler; servicing front-wheel drive transaxles; diagnosing general automatic transmission/transaxle problems; and testing related electronic components. (YLB)

ED 385 673

Automotive Service Series

Automatic Transmission/ Transaxle Specialist

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CIMC

Instructor Manual

95-011036

Oklahoma Department of
Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, OK 74074-4364

TI1233

Automatic Transmission/ Transaxle Specialist

Instructor's Manual

Upfront

Instructor's Guide

Answers

Test Code Sheets

Instructional Supplement

Developed by the
Curriculum and Instructional Materials Center
for the Division of Trade and Industrial Education
Oklahoma Department of Vocational and Technical Education

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Curriculum and Instructional Materials Center

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Printed in the United States of America by the
Oklahoma Department of Vocational and Technical Education
Stillwater, Oklahoma 74074-4364

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TABLE OF CONTENTS

Instructor's Manual

Upfront

Foreword v
Acknowledgments vii
Use of this Publication ix
Basic Skills in Curriculum xv
Measuring Student Performance Gains xix
Required Criteria for a Competency-Based Education Program xxi
Corrections and Suggestions xxiii

One set per unit of the following components:

- Instructor's Guide
- Answers
- Test Code Sheets

Instructional Supplement (one set for all units)

Instructor's Resource Package

One set per unit of the following components:

- LAP Sheet
- Transparency Masters
- Written Test
- Handouts
- Other required media

Student Workbook

One set per unit of Objective Sheets, Information Sheets, Assignment Sheets, and Job Sheets for the following units:

UNIT 1
Introduction to Automatic Transmissions and Transaxles 1-1

UNIT 2
Servicing Hydraulic System Components 2-1

UNIT 3
Servicing Rear-Wheel Drive Transmissions 3-1

UNIT 4
Servicing Torque Converter and Oil Pump 4-1

UNIT 5
Servicing Gear Train/Gearsets 5-1

UNIT 6
Servicing Friction Units and Cooler 6-1

UNIT 7
Servicing Front-Wheel Drive Transaxles 7-1

UNIT 8
Diagnosing General Automatic Transmission/Transaxle Problems 8-1

UNIT 9
Testing Related Electronic Components 9-1

FOREWORD

Students and instructors are faced with the respective challenges of learning and teaching the skills required in today's automotive service field. This curriculum is designed to help both students and instructors to meet these challenges. Additionally, it will contribute greatly to an automotive service technology program's ability to meet the requirements of a nationally-certified training school.

Automatic Transmission/Transaxle Specialist is one in a series of automotive service publications developed by the Oklahoma Department of Vocational and Technical Education. The objectives in this curriculum are based on those National Institute of Automotive Service Excellence (ASE) tasks required of a certified technician in the automatic transmission/transaxle specialty area. The ASE competencies are developed by industry to meet that industry's need for highly-trained technicians. A committee of industry representatives and educators further organized these competencies into units of instruction and validated the technical accuracy of the resulting competency-based instructional materials.

We believe that *Automatic Transmission/Transaxle Specialist* will help students continue their commitment to excellence in the automotive service industry.

Roy Peters, Jr.
State Director
Oklahoma Department of
Vocational and Technical Education

Ivan Armstrong
State Supervisor
Trade and Industrial Education
Oklahoma Department of
Vocational and Technical Education

7

ACKNOWLEDGMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to the individuals who played key roles in the development of this publication. Such a comprehensive effort requires contributions from many people. We sincerely appreciate the support necessary to complete this project.

This curriculum was written by Technical Services Company, Stillwater.

Special thanks are extended to the following persons who committed their time and expertise as members of the curriculum advisory committee. We also thank the administrators, supervisors, and others who supported their participation.

Ivan Armstrong
State Supervisor, Trade and
Industrial Education
Stillwater, OK

Gerald Christenberry
formerly of the General Motors
Training Center and Oklahoma City
Community College
Oklahoma City, OK

Charles Graham
Aspen Transmission
Broken Arrow, OK

Bill Hardin
Ouachita Vo-Tech Skills Center
Hodgen, OK

Gene Kirkpatrick
Tulsa Technology Center,
SE Campus
Broken Arrow, OK

David Neal
FLEET Transmissions
Oklahoma City, OK

William Opdyke
Moore-Norman AVTS
Norman, OK

Chuck Pendergast
Automotive Service Consultant
Oklahoma City, OK

Jon Priebe
Auto Clinic of Oklahoma City, Inc.
Oklahoma City, OK

John Roberts
Norman, OK

B. F. Rowland
Southwest AVTS
Altus, OK

Merle Taylor
AAMCO Transmissions
Oklahoma City, OK

Billy Young
Action Transmission
Tulsa, OK

The close cooperation and dedication of other professionals at the Oklahoma Department of Vocational and Technical Education were instrumental in producing this publication. The cover was designed by Colin McLain in the Art Department. Thanks are extended also to Bob Davis, Art Manager, for his direction. Special appreciation goes to artists Suzi Currier, Kim Hale, Kathryn Moore, Kathryn Northcutt, Willie Tannahill, and David Thompson for their work on the various units. Tom Fields took the cover inset photograph (with thanks to Randy Kirk for the use of his car). In the Word Processing Center, Rose Primeaux and Margie Kirkendall did an outstanding job in preparing the units and giving advice. This publication could not have been printed without the expertise and commitment of the Printing Plant staff, under the supervision of Danny Darrow. Delivering the final product was accomplished through the excellence of the staff at the CIMC Warehouse, under the direction of Darrell Stiles.

Special thanks go to the Resource Center at the Oklahoma Department of Vocational and Technical Education. The Resource Center staff answered many questions and located resources essential to the development of this publication. Those persons are Denise Christy, Manager; Julia Crawford, Assistant Manager; and Lois Friedemann, Instructional Media Specialist.

A number of people at the CIMC helped to make this product possible. Brenna Tillman, Publications Supervisor, and Charlotte Tarkington, Format Specialist, answered many questions relating to layout and design. Terri Tomson efficiently handled the development contracts and organized all of the committee meetings and related correspondence through which this book was developed. Billie Frazier, Copy Specialist, supervised the development of basic skills-related components.

This project received generous support from John Friedemann, CIMC Team Leader, and Dr. Lynna Ausburn, Development Coordinator.

A very special acknowledgement goes to Chuck Pendergast, the technical advisor for this project. Without his expert advice, this curriculum would not have been possible.

Craig A. Maile
Instructional Development Specialist

USE OF THIS PUBLICATION

INSTRUCTIONAL UNIT

Each unit of instruction is based on the performance needed for successful employment in an occupational area. *Automatic Transmission/Transaxle Specialist* contains nine units of instruction. A complete unit may contain most or all of the following components: Objective Sheet, Instructor's Guide, Information Sheet, Instructional Supplement, Assignment Sheet, Job Sheet (and Skill Test Record), Written Test, Answers (to Assignment Sheets and Written Test), Transparency Masters, Learning Activity Package (LAP) Sheet, Handouts, and other required media. These components are organized within three packages, as follows:

Instructor's Manual

- Upfront pages (title page, copyright page, table of contents, foreword, preface, acknowledgments, measuring student performance gains, required criteria for a competency-based education program, and corrections and suggestions)
- Curriculum and Duty/Task Crosswalk (as appropriate)
- Basic Skills Matrix
- One set per unit of:
    - — Instructor's Guide
    - — Answers
    - — Test Code Sheets
- Instructional Supplement (one set for all of the basic skills enablers appearing in the book)

Instructor's Resource Package

- One set per unit of:
    - — LAP Sheet
    - — Transparency Masters
    - — Written Test

  ☑ **NOTE:** The three components listed above may be photocopied by the instructor.

- Handouts (as appropriate)
- Other required media (as appropriate)

Student Workbook

- Objective Sheets
- Information Sheets
- Assignment Sheets
- Job Sheets

Instructor's materials include the *Instructor's Manual*, the *Instructor's Resource Package*, and the *Student Workbook*.

Unit components are tied to measurable and observable learning outcomes. Instructor's are encouraged to supplement unit components with other resources to make units as responsive to local conditions and student needs as possible.

Most units of instruction are designed for use in more than one lesson or class period. Instructors should determine the following for each unit:

- amount of material that can be covered in each class period;
- skills that must be demonstrated;
- supplies and equipment needed;
- amount of class time needed for demonstrations;
- amount of class time needed for student practice;
- supplementary materials to be ordered; and
- resource persons who must be contacted.

Objective Sheet (Student Workbook)

The Objective Sheet summarizes each unit for the student and the instructor. The Objective Sheet includes the following sections:

Introduction — This section introduces students to the unit topic and its importance to them. The Introduction also relates the unit to students' experiences and their "need to know"; it helps capture their interest and focus their attention on the specific topic.

Prerequisites — This section is included if any of the units in the book have prerequisites. A prerequisite may be one or more units from the same book or from other books, which must be completed before beginning the unit. (If no prerequisites exist for any of the units in the book, this section is omitted.)

Focus Assignments — Each unit has two Focus Assignments: Prereading and Writing. The Prereading assignment requires the student to read appropriate sections from unit references, from the *Instructor's Resource Package*, or from the student's textbook. The Prereading assignment leads into the Writing assignment, which assigns students a short written activity based on the Prereading assignment. Because the Focus Assignments help promote the use of basic skills, they include appropriate basic skill icons and enablers. (Activities for the basic skills associated with the Focus Assignments are included in the Instructional Supplement in the Instructor's Manual.)

Unit Objective — The Unit Objective states the overall goal of the unit. It identifies what the student will be able to do after successfully completing the unit, as well as the standards used to measure student performance.

Specific Objectives — The Specific Objectives outline the teaching sequence of the competencies required to reach the Unit Objective.

The Specific Objectives on the Objective Sheet should be emphasized to all students at the start of each unit and throughout the teaching/learning process. This will help answer student questions about performance requirements for each unit. Specific Objectives can also assist instructors in determining teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could best be taught.

Instructors should modify, delete, or add objectives to meet the needs of students and the community. When objectives are added, the instructor should remember to provide the needed information, Assignment and/or Job Sheets, and criterion-referenced test items.

Information Sheet (Student Workbook)

The Information Sheet provides the "must know" content essential for meeting the cognitive objectives in the unit. Information is usually presented in print on the Information Sheet, but may also be presented in other formats, if appropriate, such as on videotape, software, or other media. (Additional formats for presenting the Information Sheet objectives allow this component to be interactive.)

Many objectives on the Information Sheet begin with a "Words You Should Know" section. This boxed item identifies terms relating to the objective, and gives a definition for each. Terms in the "Words You Should Know" boxes are tested only indirectly with the objective information (not on the Written Test as a matching exercise).

The Information Sheet may include clarifying NOTES and EXAMPLES, as needed. In the left column, students and instructors are reminded of the optional and/or required activities and resources available for a particular objective.

Students should read the Information Sheet for each unit before it is discussed in class. Space is provided in the margins for both students and instructors to add notes that clarify and/or expand upon the information presented.

Assignment Sheets (Student Workbook)

The Assignment Sheets address the learning levels at or above the application level of Bloom's taxonomy. They allow students to perform non-psychomotor activities related to occupational tasks. Assignment Sheets also provide students with an opportunity to use higher-order thinking skills, such as problem-solving, synthesizing, analyzing, and evaluating. In addition, they may provide opportunities for cooperative learning and more detailed oral/written communication activities.

Assignment Sheet activities can be "paper and pencil" activities, as well as those using computer software, videotapes, models, handouts, or other resources as appropriate. All Assignment Sheets include basic skills icons and enablers (identified in the left margin).

Job Sheets (Student Workbook)

Job Sheets give students step-by-step procedures for performing manipulative or psychomotor occupational tasks or jobs. The Job Sheet also functions as a Skill Test Record, facilitating the instructor's evaluation of each student's performance. Both the process and the end-product are evaluated. Diagrams, illustrations, and photographs are included, as needed, to assist students in completing the job.

Individual Job Sheets may include various warnings written to conform to the latest specifications of the American National Standards Institute (ANSI). DANGER is used if the situation *will* lead to death or serious injury if not avoided; WARNING is used if the situation *could* lead to death or serious injury if not avoided; CAUTION is used if the situation could lead to minor or moderate injury; NOTICE is used if the situation could cause property damage only; and IMPORTANT is used to refer to operating or maintenance tips. Each type of warning appears on the Job Sheet with an ANSI symbol.

The instructor should demonstrate the procedure outlined in each Job Sheet. Instructors may also have to localize specific procedures.

Instructor's Guide (Instructor's Manual)

The Instructor's Guide leads instructors step by step, objective by objective through the unit. It recommends instructional strategies for the Focus Assignments and for each of the Specific Objectives. Resources and activities are labeled "R" for "Required" or "O" for "Optional." Optional and Required resources (publications, videos, computer software, and other media) are listed, as well as unit references. These resources can be used to supplement the instructor's knowledge of the subject area and to help students with particular interests or occupational objectives. In addition, the Instructor's Guide provides guidelines for evaluating student performance.

Instructors should study the Instructor's Guide before introducing the unit and allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Specific tasks of the instructor will vary with each unit.

Answers (Instructor's Manual)

This component lists the answers to all of the Assignment Sheets and the Written Test questions.

Test Code Sheet (Instructor's Manual)

The Test Code Sheet matches Written Test questions to objectives. Basic skills codes are listed in chart format for each question. Each unit has a Test Code Sheet. For more information, see the CIMC publication *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.*

Instructional Supplement (Instructor's Manual)

The Instructional Supplement provides the instructor with strategies for teaching the basic skills identified on the Focus Assignments, Assignment Sheets, and Job Sheets. One Instructional Supplement applies to all of the basic skills identified in all of the units of instruction in a book.

LAP Sheet (Instructor's Resource Package)

The LAP (Learning Activity Package) Sheet for each unit allows the instructor to individualize instruction for some or all students. The LAP Sheet guides the student through each unit step by step, ensuring that the student receives the necessary instruction.

Transparency Masters (Instructor's Resource Package)

Transparency Masters are provided so that instructors can make transparencies to accompany specific units. Transparencies allow students to *see* as well as hear the information being presented, thus reinforcing the learning process. They also direct attention to the topic under discussion. Transparencies should be made from the Transparency Masters and placed where they will be readily available when needed. Transparencies should be left on the screen only when the related topics are under discussion.

Each Transparency Master also appears in the appropriate unit in the Student Workbook, at the location where the information is referenced (such as a Figure on the Information Sheet).

Written Test (Instructor's Resource Package)

The Written Test provides criterion-referenced evaluation of the Specific Objectives from the Information Sheet (Assignment Sheet and Job Sheet objectives are not evaluated by the Written Test). If instructors have added, deleted, or modified any objectives, appropriate changes should be made to the Written Test as well.

The Written Test serves as both a pretest and a posttest. In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *essential* that the same test be used as a pretest and as a posttest. If instructors choose to use tests other than the Written Test, they should make sure that the same instrument is used for each activity — pre- and posttest.

The Written Test may be photocopied for classroom use, or additional copies may be ordered from the CIMC by calling 1-800-654-4502, or (in Oklahoma) 1-800-522-5810, ext. 589.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication *Measuring Learning & Competency Gains: The Pretest/Posttest Approach*. This booklet — and accompanying software to assist in calculating and recording student gains — are available to Oklahoma instructors through their school's vocational testing liaison.

To further assist instructors, the CIMC develops Test Code Sheets for each Written Test in its more recent publications, including this one. (These sheets are explained in detail in the publication mentioned above.) The Test Code Sheets assist in verifying that the Written Test is a valid instrument for measuring student learning and competency gains.

COMPETENCY PROFILES

A Competency Profile is available from the CIMC. Competency Profiles document student performance. Each profile lists the specific competencies covered in the book, and provides space for recording the student's level of performance on each competency.

PAGE NUMBERING

Each unit and each page in a CIMC publication has a number, shown in arabic numerals. The page number gives the package title, the book title, the component name, the unit number, and the page number within the unit. For example, the page number for page 1 in Unit 6 of the *Student Workbook* would appear as follows:

STUDENT WORKBOOK — Automatic Transmission/Transaxle Specialist
OBJECTIVE SHEET - **CIMC** - 6 - 1

METHODS OF DISSEMINATING MATERIAL

For best results, provide each student with a copy of the Student Workbook. Students should be allowed to keep their Workbooks at the end of the course or training program.

TEACHING METHODS

Keeping students motivated is a challenge. Supplement each unit with current information, personal experiences, and other information. In a group setting, prepare for each unit by determining the best way to teach each objective, and allow for student input. For individualized instruction, provide opportunities for the student to become involved in planning and being responsible for his or her own education.

BASIC SKILLS IN CURRICULUM

The CIMC has always been mindful of the importance of reinforcement (and sometimes remediation) of students' academic skills as they progress through vocational training, and has always included activities in its materials to enhance and promote use of these skills.

Recent state and federal legislation mandates vigorous basic skills development in vocational education in the wake of demands by industry that workers *must* be academically, as well as technically, competent, given the nature of the highly complex work place. In response, the CIMC has taken the following steps to document that, indeed, the instructional materials *do* combine academic skills training with the vocational training. In addition, concerted efforts have been made to "beef up," or enhance the basic skills instruction already present. Following is a brief description of those processes:

Basic Skills Icons and Enablers

To assist teachers and students in identifying activities that promote basic skills development, the CIMC has implemented a marking system that uses simple graphic symbols, or icons, and a list of specific tasks, or enablers, to identify the basic skill or skills that are called for in each job or assignment sheet.

Each of the nine broad skills areas—reading, writing, mathematics, science, oral communication, interpersonal or relating, creative thinking and problem solving, employability, and social studies—is represented by the icon presented below.

Reading

Science

Creative Thinking/
Problem Solving

Writing

Oral Communication

Employability

Math

Interpersonal or Relating

Social Studies

When an activity involving one of these basic skills is identified, the corresponding icon is placed in the left-hand margin of the job or assignment sheet. The basic skills training is further defined by retrieving the specific, or enabling, skill that is required by consulting a list of over two hundred and fifty enablers that has been compiled and grouped with each general basic skill. This enabling skill is placed directly below the icon.

As an example, an exercise that requires a student to conduct library research would make necessary the use of specific reading comprehension and research and reference skills. The basic skills that the exercise promotes would be depicted in the left-hand margin as follows:

ASSIGNMENT SHEET

PLANNING LIVING SPACE FOR HUMAN NEEDS

1

Name ______________________________ Score __________

OBJECTIVE 10

Define personal territory.

INSTRUCTIONS

Reading Comprehension
- Gain factual information

Functional Reading
- Follow written instructions
- Use content area vocabulary

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

- As discussed in objective 1, each person has an invisible "space bubble" or comfort zone. A comfort zone is the space between oneself and others that brings a feeling of well-being. When one's comfort zone is crowded or invaded, discomfort often results. Therefore, personal territory needs should be a prime consideration when planning living space.
- For each of the following situations, draw your estimated comfort zone around the figures provided.
- Indicate how many inches from your body the comfort zone extends.
- Consider how that comfort zone changes in different situations. Answer the questions that follow.

Basic Skills Documentation Matrix

Another component of the CIMC basic skills instructional plan is the "Basic Skills Documentation Matrix." The matrix graphically summarizes the basic skills training included in the vocational program, unit by unit. It should be helpful to teachers in planning their instruction, and to administrators as documentation that basic skills **are** being addressed during the vocational training.

The matrix for this publication is included as an 8½" by 11" foldout in this *Instructor's Manual.*

Matrices have been developed for most CIMC publications. For more information on those available for other programs, call the CIMC at 1-800-654-4502.

Instructional Supplement

The supplement is a tool for the instructor to use in helping students apply the basic skills in Assignment Sheets and Job Sheets. Some supplements are appropriate for use with all students; some are for use only with those students who do not understand the academic skills called for in the exercise.

MEASURING STUDENT PERFORMANCE GAINS

When you examine this book, you will notice that separate written pretests are no longer included in the units of instruction. Each CIMC unit now contains only a single Written Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	**Discussion**	**CIMC component meeting criterion**
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Written Test and Job Sheet/Skill Test

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet/Skill Test
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Competency Profile

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with accurate and effective materials. Although the CIMC strives to maintain the highest standards of development and production, oversights sometimes do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. To do this, please identify the page(s) affected and write any comments to clarify the error or suggestion. Use the spaces below. Then, simply fold (bottom of page *upward*, top *downward*), secure, and mail.

This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

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Page: Comment:

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ASE - CIMC CROSSWALK

AUTOMATIC TRANSMISSION/TRANSAXLE SPECIALIST

The following table shows the correlation between the specific tasks on the task list prepared by the National Institute of Automotive Service Excellence (ASE) and the instructional components in this CIMC (Curriculum and Instructional Materials Center) curriculum. This curriculum was prepared from the ASE task list copyrighted in 1993.

NO.	ASE TASK	CIMC UNIT/ COMPONENT
A	**GENERAL TRANSMISSION/TRANSAXLE DIAGNOSIS**	
A-1	Listen to driver's complaint and road test vehicle; determine needed repairs.	Unit 8, Job Sheet 2
A-2	Diagnose noise and vibration problems; determine needed repairs.	Unit 8, Job Sheet 2
A-3	Diagnose unusual fluid usage, level, and condition problems; determine needed repairs.	Unit 2, Job Sheet 1
A-4	Perform pressure tests; determine needed repairs.	Unit 8, Job Sheet 3
A-5	Perform stall tests; determine needed repairs.	Unit 8, Job Sheet 1
A-6	Perform lock-up converter system tests; determine needed repairs.	Unit 8, Job Sheet 4
A-7	Diagnose electronic, mechanical, and vacuum control systems; determine needed repairs.	Unit 9, Job Sheet 3 and Unit 2, Job Sheet 4
B	**TRANSMISSION/TRANSAXLE MAINTENANCE AND ADJUSTMENT**	
B-1	Inspect, adjust, and replace manual valve shift linkage.	Unit 2, Job Sheet 3
B-2	Inspect, adjust, and replace cables or linkages for throttle valve (TV), kickdown, and accelerator pedal.	Unit 2, Job Sheet 3
B-3	Adjust bands.	Unit 6, Job Sheet 5

NO.	ASE TASK	CIMC UNIT/ COMPONENT
B-4	Replace fluid and filter(s).	Unit 2, Job Sheet 1
B-5	Inspect, adjust, and replace electronic sensors, wires, and connectors.	Unit 9, Job Sheets 1, 2, and 4
C	**IN-VEHICLE TRANSMISSION/TRANSAXLE REPAIR**	
C-1	Inspect, adjust, and replace vacuum modulator, valve, lines, and hoses.	Unit 2, Job Sheet 4
C-2	Inspect, adjust, repair, and replace governor cover, seals, sleeve, valve, weights, springs, retainers, and gear.	Unit 2, Job Sheet 5
C-3	Inspect and replace external seals and gaskets.	Unit 3, Job Sheet 3 and Unit 7, Job Sheet 1
C-4	Inspect, repair, and replace extension housing.	Unit 2, Job Sheet 2 and Unit 5, Job Sheet 2
C-5	Inspect, test, flush, and replace cooler, lines, and fittings.	Unit 6, Job Sheets 6 and 7
C-6	Inspect and replace speedometer drive gear, driven gear, and retainers.	Unit 5, Job Sheet 7
C-7	Inspect valve body mating surfaces, bores, valves, springs, sleeves, retainers, brackets, check balls, screens, spacers, and gaskets; replace as necessary.	Unit 2, Job Sheet 6
C-8	Check/adjust valve body bolt torque.	Unit 2, Job Sheet 6
C-9	Inspect servo bore, piston, seals, pin, spring, and retainers; repair/replace as necessary.	Unit 2, Job Sheet 7
C-10	Inspect accumulator bore, piston, seals, spring, and retainers; repair/replace as necessary.	Unit 2, Job Sheet 8
C-11	Inspect and replace parking pawl, shaft, spring, and retainer.	Unit 5, Job Sheet 6

NO.	ASE TASK	CIMC UNIT/ COMPONENT
C-12	Inspect, test, adjust, or replace electrical/electronic components including computers, solenoids, sensors, relays, switches, and harnesses.	Unit 9, Job Sheets 1, 2, 3, and 4
C-13	Inspect, replace, and align power train mounts.	Unit 3, Job Sheets 1 and 2 and Unit 6, Job Sheets 8 and 9
D	**OFF-VEHICLE TRANSMISSION/TRANSAXLE REPAIR**	
D-1	**Removal, Disassembly, and Assembly**	
D-1.1	Remove and replace transmission/transaxle.	Unit 3, Job Sheet 1 and Unit 7, Job Sheet 2
D-1.2	Disassemble, clean, and inspect.	Unit 3, Job Sheet 2, Unit 7, Job Sheet 3, and Unit 6, Job Sheet 9
D-1.3	Assemble after servicing.	Unit 6, Job Sheet 8
D-2	**Oil Pump and Converter**	
D-2.1	Inspect converter flex (drive) plate, converter attaching bolts, converter pilot, and converter pump drive surfaces.	Unit 7, Job Sheet 4
D-2.2	Inspect, flush, measure end play, and test torque converter.	Unit 4, Job Sheets 1 and 3
D-2.3	Inspect, measure, and replace oil pump housings and parts.	Unit 4, Job Sheet 2
D-3	**Gear Train, Shafts, Bushings, and Case**	
D-3.1	Check end play and/or preload; determine needed service.	Unit 5, Job Sheet 1
D-3.2	Inspect, measure, and replace thrust washers and bearings.	Unit 5, Job Sheet 1
D-3.3	Inspect and replace shafts.	Unit 5, Job Sheet 3

NO.	ASE TASK	CIMC UNIT/ COMPONENT
D-3.4	Inspect oil delivery seal rings, ring grooves, and sealing surface areas.	Unit 5, Job Sheet 4
D-3.5	Inspect and replace bushings.	Unit 5, Job Sheet 5
D-3.6	Inspect and measure planetary gear assembly; replace parts as necessary.	Unit 5, Job Sheet 1
D-3.7	Inspect, repair, and replace case(s) bores, passages, bushings, vents, and mating surfaces.	Unit 5, Job Sheet 2
D-3.8	Inspect, repair or replace transaxle drive chains, sprockets, gears, bearings, and bushings.	Unit 7, Job Sheet 5
D-3.9	Inspect, measure, repair, adjust or replace transaxle final drive components.	Unit 7, Job Sheet 6
D-4	**Friction and Reaction Units**	
D-4.1	Inspect clutch assembly; replace parts as necessary.	Unit 6, Job Sheet 1
D-4.2	Measure and adjust clutch pack clearance.	Unit 6, Job Sheet 2
D-4.3	Air test the operation of clutch and servo assemblies.	Unit 6, Job Sheet 3
D-4.4	Inspect one-way clutch assemblies; replace parts as necessary.	Unit 6, Job Sheet 4
D-4.5	Inspect and replace bands and drums.	Unit 6, Job Sheet 5

INSTRUCTOR'S GUIDE

INTRODUCTION TO AUTOMATIC TRANSMISSIONS AND TRANSAXLES

1

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the introductory material to automatic transmissions/transaxles in the textbook you use for instruction.

R Have students read the unit objective and the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

Writing

R Have students research and write a brief history of the automatic transmission. Guide students to appropriate resource materials.

O Have students give brief extemporaneous speeches in which they introduce themselves to the other class members, identify the type of vehicle they own or are interested in owning, and outline their experiences with automatic transmissions.

O Have a student read aloud the introduction to the unit.

O Show the video *Automatic Transmission: Basic Parts and Principles—Parts One and Two.* Encourage students to take notes and to ask questions at the conclusion of the video.

> ☑ **NOTE:** For ordering information, see the "Optional Resources" section.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

- R Make sure that all tools, equipment, and supplies are available.
- R Demonstrate each of the procedures outlined in the Job Sheet.
- R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.
- R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.
- R Complete each student's Competency Profile.
- R Return the completed Job Sheets to the students so that they may use them for later reference if needed.
- O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

- R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.
- R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Correct false statements about hydraulic theory.

- R Review the definitions of the terms in the "Words You Should Know" box.
- R Have students study the figures in this section of the Information Sheet.
- R Use Transparency Master 1 to illustrate Pascal's Law.
- R Use Transparency Master 2 to illustrate the transmittal of motion and force from one cylinder to another.

R Use Transparency Master 3 to illustrate how piston surface area multiplies force.

R Use Transparency Master 4 to illustrate how stroke length as well as piston diameter affect the fluid volume needed to stroke a piston.

O Call on different students to explain the theories outlined in this section of the Information Sheet.

O Conduct demonstrations to illustrate the theories presented in this section of the Information Sheet.

OBJECTIVE 2 **Solve problems involving Pascal's Law. (Assignment Sheet)**

R Have students read the instructions and examples in Part 1.

O Read the example problems with the students and then work several additional problems on the chalkboard before assigning the problems in Part 2.

OBJECTIVE 3 **Explain the functions of basic components common to simple hydraulic systems.**

R Have students study the figure in this section of the Information Sheet.

R Use Transparency Master 5 to illustrate the basic components of a simple hydraulic system.

R Review with students the primary functions of each of the components of a simple hydraulic system.

O Have students quiz each other on the functions of the components of a simple hydraulic system.

OBJECTIVE 4 **Explain how a torque converter functions as both a fluid coupling and a torque multiplier.**

R Review the definitions of the words in the "Words You Should Know" box.

R Have students study the figures in this section of the Information Sheet.

R Use Transparency Master 6 to illustrate power transfer.

R Use Transparency Master 7 to illustrate torque multiplication.

R Show students an example of a stator, impeller, and turbine.

O Set up two fans to demonstrate air power transfer.

O Call on individual students to explain fluid coupling and torque multiplication.

OBJECTIVE 5

Label the basic components of an automatic transmission and an automatic transaxle.

R Have students study the figures in this section of the Information Sheet.

R Use Transparency Master 8 to illustrate the basic components of an automatic transmission.

R Use Transparency Master 9 to illustrate the basic components of an automatic transaxle.

R Relate the basic transmission/transaxle components presented in this objective to the basic components common to simple hydraulic systems presented in Objective 3.

R Show students an actual transmission and transaxle. Compare and contrast them. Point out and explain the components of each.

O Have students identify on an actual transmission and transaxle each of the components shown on the transparencies.

O Divide the students into teams, or have students pair off, and quiz each other on the names and locations of the transmission/transaxle components.

OBJECTIVE 6

List types of automatic transmissions/transaxles.

R Review the definitions of the terms in the "Words You Should Know" box.

R Use Transparency Master 10 to illustrate a modern four-speed stepped-ratio transmission.

R Use Transparency Master 11 to illustrate a modern overdrive stepped-ratio transaxle. Point out and explain the differences between a transaxle and a transmission.

R Show an example of an electronic continuously variable transmission (ECVT). Point out and explain the differences between the ECVT and the stepped-ratio transmissions/transaxles.

R Use Transparency Master 12 to illustrate a nonplanetary gear transmission. Point out and explain how this transmission differs from the stepped-ratio and continuously variable transmissions.

O Show students examples of each of the following types: RWD, FWD, FWD transaxle, all-wheel drive, overdrive, and electronically-controlled.

O Divide the students into teams, or have students pair off, and describe to each other the different transmission/transaxle types.

OBJECTIVE 7 **List the advantages and disadvantages of conventional automatic transmissions/transaxles over manual transmissions.**

R Explain each of the advantages and disadvantages.

O Call on individual students to recite the advantages and disadvantages of conventional automatic transmissions/transaxles.

OBJECTIVE 8 **Distinguish between symptoms that require simple service and those that require overhaul or repair.**

O Call on a student (or students) to read the reasons aloud.

O If possible, show students examples of each of the symptoms.

OBJECTIVE 9 **State reasons for identifying a transmission before servicing.**

O Call on a student (or students) to read aloud the reasons for identifying a transmission before service.

O Provide anecdotal examples of technicians who were stumped, or who found themselves without the correct replacement part, because they failed to identify the transmission before servicing.

OBJECTIVE 10

State ways of identifying an automatic transmission before servicing.

- R Have students study the figures in this section of the Information Sheet.
- R Use Transparency Master 13 to illustrate sample automatic-transmission pan-gasket shapes.
- O Order and post "MOTOR Automatic Transmission Identification Chart."
- O Use pan-gasket shapes like flashcards to quiz students on the make and model transmission to which the different shapes belong.
- O Divide the class into teams. Provide each team with several different serial numbers and service manuals. The team that is first to correctly match its serial numbers to the correct make and model transmission wins the competition.
- O Divide the class into teams. Provide each team with several different pan-gasket designs and service manuals. The team that is first to correctly match its gasket configurations with the correct make and model transmission wins the competition.

OBJECTIVE 11

Answer questions about automatic transmission fluid.

- R Review the definitions of the terms in the "Words You Should Know" box.
- O Show students examples of typical ATF (red), aftermarket "racing" ATF (blue), and Ford CJ ATF (gold).
- O Demonstrate the color change that occurs when water contaminates transmission fluid.
- O Allow students to smell transmission fluid from an overheated or abused transmission.

OBJECTIVE 12

State the functions of automatic transmission fluid.

- R Describe how the ATF accomplishes each function.

OBJECTIVE 13

List the effects of too little or too much automatic transmission fluid.

- R Review the definitions of the terms in the "Words You Should Know" box.
- R Ask the following questions:
    - ☐ Why do you think too little and too much transmission fluid lead to aeration?
    - ☐ Why do aerated ATF and too little ATF lower hydraulic pressure?
    - ☐ Why do aerated ATF and too much ATF lead to overheating?
- O Show students examples of *aerated ATF.*
- O Show students examples of oil-pan screens containing *varnish buildup.*
- O Show students examples of *oxidation.*

OBJECTIVE 14

Explain the functions of given friction devices.

- R Review the definitions of the terms in the "Words You Should Know" box.
- R Have students study the figures in this section of the Information Sheet.
- R Use Transparency Master 14 to illustrate the locations of various friction devices on a typical automatic transmission.
- O Call on individual students to explain the functions of the various friction devices listed.
- O Show students actual examples of drums, bands, servos, accumulator pistons, and multiple-disc and overrunning clutches on a vehicle.

OBJECTIVE 15

Match automatic transmission gear indicators/gears with their functions.

- O Have students quiz each other on the functions of the various automatic transmission gears/gear indicators.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.
- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.
- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.
- Describe the rating scale used on the skills test.
- Reteach and retest as necessary.
- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.

- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.

- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.

- Complete the appropriate sections of the Competency Profiles.

- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate service manuals for different vehicle makes and models, as needed for "Required" and "Optional" activities.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "Industry and Education, 'Hand in Hand,'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with ASE test format.

Videos

- *Automatic Transmission: Basic Parts and Principles—Parts One and Two.* Bergwall Productions, Inc., 540 Baltimore Pike, Chadds Ford, PA 19317-9304, (800) 654-3565.

Computer Software

- *Drive Trains: Automatic Transmissions*, Apple or IBM format, AAVIM, 745 Gaines School Road, Athens, GA 30605, (800) 228-4689.

Other Media

- Poster: "MOTOR Automatic Transmission Identification Chart." Motor Publications, P.O. Box 720001, Oklahoma City, OK 73172, phone (405) 721-0310.
- Competency profile

  ☑ **NOTE:** A competency profile for this book is available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364. If ordering by phone, in-state callers should dial 1-800-522-5810 (ext. 589). Out-of-state callers should dial 1-800-654-4502.

UNIT REFERENCES

Publications

- Birch, Thomas W. *Automatic Transmissions/Transaxles.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.
- Bono, Saverio G. and William J. deKryger. *Auto Technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.
- Chek-Chart Publications. *Automatic Transmissions and Transaxles: Classroom Manual*, 2nd ed. New York, NY: Harper & Row Publishers, 1989.
- Duffy, James E. *Modern Automotive Mechanics.* South Holland, IL: Goodheart-Willcox Company, Inc., 1990.
- Freeman, Kerry A., Editor-in-Chief. *Chilton's Guide to Automatic Transmission Repair: 1984-89 Domestic Cars & Light Trucks.* Radnor, PA: Chilton Book Company, 1990.
- General Motors Corporation. *Hydra-Matic 4T60: Technician's Guide.* Ypsilanti, MI: Powertrain Division of General Motors Corporation, July 1991.

- Kovacik, Robert T., and Saverio G. Bono. *Automatic Transmissions.* Cincinnati, OH: South-Western Publishing Co., 1984.
- Kromida, Michael J. *Motor Domestic Transmission Manual: Professional Service Trade Edition.* 3rd ed. Troy, MI: Hearst Books/Business Publishing Group, 1990.
- Mitchell International, Inc., *Mitchell Automatic Transmissions and Transaxles: Fundamentals and Systems.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1989.
- Mitchell International, Inc. *Mitchell Automechanics.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1991.
- White, John, H. *Automatic Transmissions.* Albany, NY: Delmar Publishers, Inc., 1990.

ASSIGNMENT SHEET

OBJECTIVE 2

Assignment Sheet

1. 400 psi
   2,758 kPa

2. 300 pounds
   1,320 Newtons

3. 2 square inches
   13.08 square centimeters

4. 83.3 psi
   574.3 kPa

5. 400 pounds
   1,760 Newtons

6. 50 psi
   344.7 kPa

7. 200 pounds
   880 Newtons

8. 2.75 square inches
   17.98 square centimeters

WRITTEN TEST

OBJECTIVE 1

1. Liquids cannot be *compressed.*

3. *Pascal's Law* states that liquids transmit pressure equally in all directions; therefore, hydraulic pressure acts with equal force on all surfaces.

4. Applied force is *directly* related to the results obtained.

6. A hydraulic system *can only transmit energy that is put into it; it cannot create energy.*

7. Motion and force can be transmitted—*without change*—from one cylinder to another through tubing.

8. It *is possible* to change motion to force or vice versa.

11. The volume of fluid required to stroke a piston is determined by the *length of the stroke* and the diameter of the piston.

OBJECTIVE 2

Evaluated on the Assignment Sheet.

OBJECTIVE 3

1. Supplies input power
2. Transmits power
3. Holds the fluid
4. Prevents impurities from contaminating the fluid
5. Route the fluid
6. Control the power
7. Provide system output

OBJECTIVE 4

Fluid coupling

- A simple fluid coupling consists of an impeller and a turbine.

- The impeller is connected to the engine flywheel through the fluid-coupling metal housing.

- The turbine is placed closely in front of the impeller, separated by a small space.

- Power transfer occurs when the impeller throws oil against the turbine causing the turbine to turn.

- While air is the medium of power transfer with the fans, oil is the medium of power transfer with a fluid coupling.

Torque multiplier

- A stator—mounted on a one-way clutch that allows it to rotate clockwise but not counterclockwise—is added between the impeller and the turbine.

- The stator redirects counterclockwise oil returning from the turbine and changes its direction back to the direction of the impeller.

- Torque multiplication occurs when the fluid is returned to the impeller in a clockwise rotation, causing the impeller to spin *faster* than the turbine and the one-way clutch to lock the stator.

- The energy in the oil is then used to help turn the impeller, thus increasing the force of the oil driving the turbine and multiplying the torque, or twisting force, of the engine.

- Vortex flow occurs at stall and lower speeds.

- Rotary flow occurs at higher road speeds as the impeller, stator, turbine, and fluid all rotate in the same direction at approximately the same speed.

OBJECTIVE 5

Automatic transmission assembly

1. Torque converter
2. Input shaft
3. Clutch assemblies
4. Case
5. Extension housing
6. Output shaft
7. Bands
8. Governor
9. Valve body
10. Shift lever
11. Oil pan
12. Oil pump

Automatic transaxle assembly

1. Oil pan
2. Control valve and pump assembly
3. Case
4. Torque converter
5. Low and reverse clutch plate assembly
6. Final drive internal gear
7. Bands
8. Intermediate servo piston
9. Differential assembly
10. Output shaft
11. Governor assembly
12. Drive link assembly

OBJECTIVE 6

1. Electronic continuously variable transmission
2. Nonplanetary gear transmission
3. Stepped-ratio transaxle
4. Stepped-ratio transmission

OBJECTIVE 7

Answer should include any three of the following advantages and the three following disadvantages.

Advantages

- Do not require driver to manually select gears
- Do not require driver to depress a clutch pedal
- Provide a smoother, more consistent transfer of power from engine to transmission
- Computer controls provide better acceleration and greater fuel economy
- Weigh less and are relatively less bulky
- Provide better emission control because engine does not decelerate during shifts

Disadvantages

- Have more moving parts
- Are more complex
- Do not allow engine to operate at maximum efficiency

OBJECTIVE 8

2, 4, 5, 8, 9

OBJECTIVE 9

1. Without this essential information, the technician cannot be sure that the correct parts and procedures will be used.
2. The same make and model vehicle may have several transmission options.
3. After the vehicle was purchased, a transmission of a different year or model may have been installed.

OBJECTIVE 10

1. Matching the shape of the oil pan with a pan or pan-gasket chart
2. Checking the transmission identification tag or serial number against the service manual's decoding information

3. Checking the transmission's composition and shape and the location of its external components against the service manual's descriptions

OBJECTIVE 11

1. Red
2. Blue
3. Gold
4. Generally a cause for concern and a sign that there may be a problem
5. Water contamination
6. Mild, pleasant
7. That the transmission may have been overheated or abused

OBJECTIVE 12

1. Provides a coupling between the engine and the transmission
2. Removes heat from the transmission and transfers it to outside air via the transmission's oil cooler
3. Lubricates the transmission's moving parts
4. Provides pressure to operate clutch pistons and band servos

OBJECTIVE 13

Effect of too little ATF

Fluid can become aerated, leading to low hydraulic pressure; low hydraulic pressure will cause delays in clutch and band application.

Effects of too much ATF

1. Fluid can become aerated, leading to overheating, oxidation, and varnish buildup.
2. Fluid may be forced from the vent.

OBJECTIVE 14

1. Cast-iron, aluminum, or stamped steel housing splined to a planetary gear; when stopped, stops gear rotation; may be engine driven, in which case it drives forward gear
2. Lined metal strap that wraps around a drum; used to stop or hold a drum stationary

3. Hydraulic piston used to apply the band

4. Piston used to cushion the servo in applying the band or clutch quickly and smoothly

5. Stack of discs arranged in alternate fashion, the driving discs splined to the clutch hub and the driven discs splined to the clutch drum; when the clutch is applied, the discs press together to lock the clutch hub and drum together

6. Mechanism that locks the component in one direction and allows rotation in the other

OBJECTIVE 15

1. D
2. A
3. F
4. B
5. E
6. C

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) **Automatic Transmission/Transaxle Specialist**

UNIT NUMBER AND TITLE — 1 — Introduction to Automatic Transmissions and Transaxles

TOTAL NUMBER OF TEST QUESTIONS **92**

TOTAL NUMBER OF BASIC SKILL QUESTIONS **25**

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-11	W
2	Evaluated on the AS	
3	1-7	W
4	1	W
5	1-12, 1-12	X
6	1-4	X
7	1-3, 1-3	X
8	1-9	X
9	1-3	X
10	1-3	X
11	1-7	X
12	1-4	X
13	1	X
14	1-6	W
15	1-6	X

INSTRUCTOR'S GUIDE

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible Handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the section on hydraulics in the textbook you use for instruction.

Writing

R Have students write a list of cautions and warnings related to servicing an automatic transmission hydraulic system.

Optional Activities and Resources

- O Have students give brief extemporaneous speeches in which they introduce themselves to the other class members, identify the type of vehicle they own or are interested in owning, and outline their experiences with automatic transmission hydraulic systems.
- O Have a student read aloud the introduction to the unit.
- O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.
- O Show video *Automatic Transmission: Operation of Hydraulic Circuits—Parts One and Two.* Encourage students to take notes and to ask questions at the conclusion of the video.

GENERAL INSTRUCTIONS

Assignment Sheets

- R Review the directions and any specific guidelines.
- R Make certain that any needed materials from the Instructor's Resource Package are available.
- R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.
- R Complete each student's Competency Profile.
- O Have the students volunteer to read aloud the directions and any special guidelines.
- O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

- R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.
- R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Label basic hydraulic-related components of a modern four-speed automatic transmission/transaxle.

R Display basic hydraulic-related components.

O Refer students to examples of four- and three-speed transaxles. Point out the similarities and differences in these transaxles and the four-speed automatic transmission.

O Show students examples of each component on a bench model transmission.

O Discuss variations in component placement and design on various vehicle makes and models.

OBJECTIVE 2 **Describe the functions of basic hydraulic-related automatic transmission components.**

- R Provide examples and analogies and explain functions in more detail.
- R Show students actual examples of bushings, gaskets, seals, and filters.
- O Call on different students to read aloud the functions of the automatic transmission components.

OBJECTIVE 3 **Label the parts of a typical throttle linkage on a rear-wheel drive transmission.**

- R Have students study the illustration of the typical throttle linkage.
- R Use Transparency Master 1 to illustrate and discuss the basic components of a typical throttle linkage.
- O Show students examples of throttle linkage components.
- O Have students locate the throttle linkage on a rear-wheel drive vehicle.
- O Have students quiz each other over throttle linkage component names.

OBJECTIVE 4 **State the purpose of a vacuum modulator.**

- R Use Transparency Master 2 to illustrate a dual-area vacuum control diaphragm unit.

OBJECTIVE 5 **List problems caused by a defective vacuum modulator.**

- R Provide examples and analogies to describe the problems caused by a defective vacuum modulator in more detail.

OBJECTIVE 6 **State the purpose of the transmission governor.**

- R Explain how the vacuum modulator and governor work together to determine shift points.

OBJECTIVE 7

Label the parts of a typical governor assembly.

- R Display the parts of a typical governor assembly.
- O Have students locate the governor on a rear-wheel drive vehicle.
- O Have students quiz each other over governor component names.

OBJECTIVE 8

List possible sources of transmission fluid leaks.

- R Identify on a bench model each of the possible leak sources.

OBJECTIVE 9

Describe common methods of identifying leaks.

- O Demonstrate each of the leak detection methods described.

OBJECTIVE 10

Label the basic parts of a valve-body assembly.

- R Have students study the illustration of the valve body.
- R Use Transparency Master 3 to point out and explain the basic parts of a valve-body assembly.
- O Have students identify on an actual valve body each of the components shown on the transparency.

OBJECTIVE 11

Identify types of valves used in automatic transmission valve bodies.

- R Have students study the illustrations of the valves.
- R Use Transparencies 4 and 5 to illustrate the different valves used in valve bodies. Leave the transparency displayed to help you point out valve characteristics and functions as outlined in Objective 12.
- O Show students actual examples of each type of valve.

OBJECTIVE 12

Match types of valve-body valves with their characteristics.

- R Review the definitions of the terms in the "Words You Should Know" box.

R Show students an example of a spool valve, pointing out its lands, faces, and valleys.

R Use Transparency Master 6 to illustrate the parts of a spool valve.

R Stress the information in the notes.

O Call on different students to read aloud the characteristics of the different valves.

O Show students examples of each of the valves.

O Point out each of the different valves as they are arranged in the valve body. Allow students to inspect the spool valves in the valve body to see the precision and closeness of their fit.

OBJECTIVE 13

Label the basic parts of a typical servo assembly.

R Have students study the illustration of the servo assembly.

R Use Transparency Master 7 to point out the parts of a typical servo assembly.

O Show students an example of an actual servo assembly.

OBJECTIVE 14

Identify types of servo operating linkages.

R Review the definitions of the terms in the "Words You Should Know" box.

R Show students examples of each of the terms on actual servo linkages.

R Have students study the illustrations of servo operating linkages.

R Use Transparency Master 8 to illustrate and explain servo operating linkages. Leave the transparency displayed to help you explain how the linkages adjust band tightness as presented in the "Words You Should Know" box.

O Show students examples of the various servo operating linkages.

OBJECTIVE 15 **State the purpose of the accumulator.**

O Show students an accumulator, or refer students to an exploded view of an accumulator in a shop manual.

OBJECTIVE 16 **Service a transmission. (Job Sheet 1)**

R Show students where the transmission fluid dipstick is located on various makes and models of vehicles.

R Show students variously marked dipsticks, and explain how to interpret them. Remind students that transmission fluid is measured in pints—not quarts—as is engine oil.

R Discuss the importance of cleanliness when servicing the transmission. Remind students that all parts should be air-dried or dried with compressed air.

R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost or damaged.

OBJECTIVE 17 **Remove and replace extension housing bushing and seal (including microsleeve). (Job Sheet 2)**

R Show students how to locate the extension housing bushing and seal (including microsleeve) on various vehicle makes and models.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

R Review the guidelines for performing extension housing bushing and seal replacement.

R Demonstrate the procedure, following service manual steps for make and model demonstrated.

R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

O Have students find the procedure in the appropriate service manuals for the make and model being serviced. Once the procedure has been found, have a student, or students, read aloud any cautions or warnings related to the service.

OBJECTIVE 18

Check and adjust or replace manual shift valve and throttle valve (TV) linkages/cables. (Job Sheet 3)

- R Show students how to locate the manual shift valve and throttle valve linkages and cables on a rear-wheel drive vehicle.
- R Review and explain general inspection guidelines, safety cautions, and warnings.
- R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.
- R Demonstrate the procedure, following service manual steps for make and model demonstrated.
- R Provide students with appropriate service manuals, tools, equipment, work order, and work area.
- O Have different students read aloud the job guidelines.
- O Have students find the procedure in the appropriate service manuals for the make and model being serviced. Once the procedure has been found, have a student, or students, read aloud any cautions or warnings related to the service.

OBJECTIVE 19

Inspect and replace vacuum modulator, lines, and hoses. (Job Sheet 4)

- R Show students how to locate the vacuum modulator, lines, and hoses on both FWD and RWD vehicles.
- R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.
- R Demonstrate each of the subprocedures outlined.
- R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

OBJECTIVE 20

Inspect and replace governor assembly. (Job Sheet 5)

- R Show students how to locate the governor assembly on various makes and models of vehicles.
- R Review and explain the general guidelines and notes.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

R Demonstrate the procedure, following service manual steps for make and model demonstrated.

R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

O Have different students read aloud the job guidelines.

O Have students find the procedure in the appropriate service manuals for the make and model being serviced. Once the procedure has been found, have a student, or students, read aloud any cautions or warnings related to the service.

OBJECTIVE 21

Remove and repair or replace valve body. (Job Sheet 6)

R Show students how to locate the valve body on various vehicle makes and models.

R Review and explain general inspection guidelines, safety cautions, and warnings.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

R Remind students of the importance of maintaining an impeccably clean work area when servicing valve bodies.

R Demonstrate the procedures, following service manual steps for make and model demonstrated.

R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

O Have students find the procedure in the appropriate service manuals for the make and model being serviced. Once the procedure has been found, have a student, or students, read aloud any cautions or warnings related to the service.

OBJECTIVE 22

Remove and repair or replace a servo assembly. (Job Sheet 7)

R Show students how to locate the servo assembly on various vehicle makes and models.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

R Demonstrate the procedure, following service manual steps for make and model demonstrated.

R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

O Have students find the procedure in the appropriate service manuals for the make and model being serviced. Once the procedure has been found, have a student, or students, read aloud any cautions or warnings related to the service.

OBJECTIVE 23

Inspect an accumulator. (Job Sheet 8)

R Show students how to locate the accumulator on various vehicle makes and models.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

R Demonstrate the procedure outlined.

R Provide students with appropriate service manuals, tools, equipment, work order, and work area.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.

- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.

- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.

- Describe the rating scale used on the skills test.

- Reteach and retest as necessary.

- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.

- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.

- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.

- Complete the appropriate sections of the Competency Profiles.

- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in Job Sheet procedures.

OPTIONAL RESOURCES

Publication

- Certification Test Booklet: "Industry and Education, 'Hand in Hand'", ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Videos

- *Automatic Transmission: Operation of Hydraulic Circuits—Parts One and Two.* Bergwall Productions, Inc., 540 Baltimore Pike, Chadds Ford, PA 19317-9304, (800) 645-3565.

- *C5 Automatic Transmission Operation and Diagnosis*, Ford Service Publications, P.O. Box 07150, Detroit, MI 48207, (800) 782-4356.

Computer Software

- *Drive Trains: Automatic Transmissions.* Apple or IBM format, AAVIM, 745 Gaines School Road, Athens, GA 30605, (800) 228-4689.

Other Media

- "Automatic Transmission Repair Worksheets," ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

- Competency Profiles

  ☑ **NOTE:** Competency Profiles for this book are available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364. If ordering by phone, in-state callers should dial 1-800-522-5810, ext 589. Out-of-state callers should dial 1-800-654-4502.

UNIT REFERENCES

- Birch, Thomas W. *Automatic Transmissions/Transaxles.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.
- Bono, Saverio G. and William J. deKryger. *Auto Technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.
- Chek-Chart Publications. *Automatic Transmissions and Transaxles: Classroom Manual*, 2nd ed. New York, NY: Harper & Row Publishers, 1989.
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- Duffy, James E. *Modern Automotive Mechanics.* South Holland, IL: Goodheart-Willcox Company, Inc., 1990.
- Freeman, Kerry A., Editor-in-Chief. *Chilton's Guide to Automatic Transmission Repair: 1984-89 Domestic Cars & Light Trucks.* Radnor, PA: Chilton Book Company, 1990.
- Kovacik, Robert T. and Saverio G. Bono. *Automatic Transmissions.* Cincinnati, OH: South-Western Publishing Co., 1984.
- Mitchell International, Inc. *Mitchell Automatic Transmissions and Transaxles: Fundamentals and Systems.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1989.
- Mitchell International, Inc. *Mitchell Automechanics.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1986, 1991.
- Stockel, Martin W. and Martin T. Stockel. *Auto Service and Repair.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1989.
- White, John, H. *Automatic Transmissions.* Albany, NY: Delmar Publishers, Inc., 1990.

C1

WRITTEN TEST

OBJECTIVE 1

The following components must be identified in the proper numbered blanks:

- Reverse servo
- Intermediate servo
- Overdrive servo
- Case
- Valve-body assembly
- Oil pan screen
- Oil pan gasket
- Oil sump pan
- Governor assembly
- Dipstick and filler tube

OBJECTIVE 2

1. Changes forward gear ratios automatically
2. Stores hydraulic energy to regulate shift quality
3. Provides a bearing surface for rolling parts
4. Houses the transmission internal components
5. Houses rear part of transmission and output shaft coupling
6. Seals two parts together to contain fluid and keep out contaminants
7. Screens dirt and metal particles from transmission fluid
8. Prevents oil leaks around a shaft
9. Transfers hydraulic force
10. Transfers fluid from one point to another and also creates hydraulic pressure
11. Converts hydraulic pressure into mechanical motion

12. Controls fluid flow and pressure

13. Controls pressures and direction of fluid flow

OBJECTIVE 3

1. Throttle valve cable
2. Return spring
3. Shift cable bracket
4. Gear selector lever
5. Throttle valve lever
6. Throttle valve cable bracket

OBJECTIVE 4

Senses engine load and causes the hydraulic valve to change pressure relative to that load

OBJECTIVE 5

Answer should include any four of the following:

- Harsh upshifts or downshifts
- Soft upshifts or downshifts
- Delayed upshifts
- Slippage in low, drive, or reverse
- Transmission overheating
- Transmission fluid burning by engine

OBJECTIVE 6

Controls (or governs) hydraulic circuit pressure on one end of the shift valve

OBJECTIVE 7

The following parts must be identified in the proper numbered blanks:

- Governor shaft
- Output shaft
- Drive gear
- Driven gear
- Primary weight
- Secondary weight
- Primary check ball
- Secondary check ball
- Secondary spring
- Oil seal ring

OBJECTIVE 8

Any ten (10) of the following:

1. Case
2. Converter
3. Cooler, connectors, and plugs
4. Electrical connector seal
5. Extension oil seal assembly
6. Extension-to-case seal
7. Governor cover
8. Manual shaft seal
9. Oil fill-tube seal
10. Oil pan
11. Oil pump seal assembly
12. Oil pump-to-case seal
13. Servo cover
14. Speedo seal
15. TV cable seal
16. Vent

OBJECTIVE 9

1. Examining seals, joints, and components in suspect area for evidence of leakage

2. Cleaning of transmission housing and engine; bringing the engine and transmission to operating temperature; and visually examining the transmission-housing seals and joints with a trouble light

3. Filling component with compressed air and submerging in water or spraying with soapy water solution to check for the escape of air bubbles that would indicate a leak

4. Using a vacuum tester to determine whether the modulator will hold vacuum

5. Spraying suspect area with leak-detecting additive and then passing an ultraviolet light over the area to highlight leak

6. Spraying suspect area with leak-detecting powder and looking for fluid trails

OBJECTIVE 10

1. Worm tracks
2. Reinforcement plate
3. Separator plate
4. Separator gasket
5. Valve body
6. Valve bores
7. Valves (installed)
8. Detent spring

C4

OBJECTIVE 11

1. Poppet valve
2. Balance valve
3. Check-ball valve

OBJECTIVE 12

1. C
2. A
3. D
4. B

OBJECTIVE 13

1. Snap ring
2. O-ring
3. Servo cover
4. O-ring
5. Piston seal
6. Servo piston
7. Piston seal
8. Servo return spring
9. Band assembly

OBJECTIVE 14

1. Cantilever linkage
2. Lever linkage
3. Straight linkage

OBJECTIVE 15

1. Acts as a shock absorber to cushion band or clutch application

2. Assists the servo in applying the brake band or clutch quickly, yet smoothly

OBJECTIVES 16-23

Evaluated on Job Sheets 1-8.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) Automatic Transmission/Transaxle Specialist

UNIT NUMBER AND TITLE — 2 — Servicing Hydraulic System Components

TOTAL NUMBER OF TEST QUESTIONS 90

TOTAL NUMBER OF BASIC SKILL QUESTIONS 19

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-10	X
2	1-13	W
3	1-6	X
4	1	X
5	1-4	X
6	1	X
7	1-10	X
8	1-10	X
9	1-6	W
10	1-8	X
11	1-3	X
12	1-4	X
13	1-9	X
14	1-3	X
15	1-2	X
16-23	Evaluated on JS 1-8	

INSTRUCTOR'S GUIDE

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

3

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the material in their textbooks about rear-wheel drive transmissions.

Writing

R Have students write a paragraph or two in which they discuss the advantages and disadvantages of RWD as compared to FWD.

R Guide students to appropriate resource materials.

O Have students give brief reports to the class on the type of transmission (RWD transmission/FWD transaxle) they have (or would like) in their vehicles. Ask the students to elaborate on whether the type of drive/transmission entered into their decision to select their particular vehicle.

O Have a student read aloud the introduction to the unit.

O Have students read the unit objective and the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Answer questions about the characteristics of rear-wheel drive automatic transmissions.

R Have students study the illustration of the rear-wheel drive automatic transmission.

OBJECTIVE 2

Label the parts of a typical console shift-linkage arrangement on a rear-wheel drive transmission.

R Have students study the illustration of the typical console shift-linkage arrangement.

R Use Transparency Master 1 to illustrate and discuss the basic components of the console shift linkage.

O Show students examples of console shift-linkage components.

O Have students locate the console shift linkage on a rear-wheel drive vehicle.

O Have students quiz each other over typical console shift linkage component names.

OBJECTIVE 3

Label the parts of a typical column shift linkage on a rear-wheel drive transmission.

R Have students study the illustration of the typical column shift-linkage arrangement.

R Use Transparency Master 2 to illustrate and discuss the basic components of a typical column shift linkage.

O Show students examples of column shift-linkage components.

O Have students locate the column shift linkage on a rear-wheel drive vehicle.

O Have students quiz each other over typical column shift-linkage component names.

OBJECTIVE 4

Describe the functions of various types of automatic transmission linkages and controls.

R Provide examples and analogies and explain functions in more detail.

R Show students examples of the various switches and linkages.

O Call on different students to read aloud the functions of the automatic transmission linkages and controls.

O Have students locate the various linkages and controls on a rear-wheel drive vehicle.

O Have students quiz each other on the functions of the automatic transmission linkages and controls listed.

OBJECTIVE 5

List indicators of improper linkage adjustment.

R Provide examples and analogies and explain indicators of improper linkage adjustment in more detail.

R Refer students to Figure 4. Explain what happens when a misadjusted manual shift linkage places the manual valve in the wrong position. Use Transparency Master 3 to illustrate your explanation.

R Review the definition of the term "gate stop" in the "Words You Should Know" box.

R Refer students to Figure 5, and use it and Transparency Master 4 to explain the note that precedes it.

O Call on a student to explain Figure 4.

O Call on students to read aloud and explain the notes.

O Have students quiz each other on indicators of improper linkage adjustment.

OBJECTIVE 6 **Name terms associated with replacement seals.**

R Show students examples of each term where applicable.

R Explain why seal fit is important.

R Use Transparency Master 5 to show students features of different types of seals.

OBJECTIVE 7 **Label bushings, thrust bearings, and thrust washers typically used on modern transmissions.**

R Review definitions of the terms in the "Words You Should Know" box.

R Display at least ten (10) bushings, thrust bearings, and thrust washers. Label each item by name so that students can study them.

O Show students the locations of bushings, thrust washers, and thrust bearings on an actual RWD transmission.

OBJECTIVE 8 **List reasons why a specified amount of endplay is necessary in automatic transmissions.**

O Describe what is happening in each case.

OBJECTIVE 9 **State reasons for endplay adjustment.**

R Explain each reason.

OBJECTIVE 10

Remove a transmission. (Job Sheet 1)

- R Show students how to use a transmission jack.
- R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

OBJECTIVE 11

Disassemble and clean a transmission. (Job Sheet 2)

- R Show students how to use a parts-cleaning machine.
- R Discuss the importance of cleanliness when servicing the transmission.
- R Show students how to arrange their work areas to keep their tools readily accessible and the transmission components clean and in order.
- R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

OBJECTIVE 12

Replace external seals and gaskets. (Job Sheet 3)

- R Show students how to keep the old seals with the old component until it is time to replace the seals.
- R Show students how to locate the external seals and gaskets on a rear-wheel drive vehicle.
- R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.
- R Demonstrate how to check round and square-cut seals for fit. Allow students to return your demonstration.
- R Demonstrate how to check lip-type seals for fit. Allow students to return your demonstration.
- R Demonstrate how to check hook-type and butt-type metal sealing rings for fit. Allow students to return your demonstration.
- R Demonstrate how to check solid and scarf-cut Teflon® sealing rings for fit. Allow students to return your demonstration.

O Provide students with examples of each kind of seal. Have students quiz each other on the seal names/types and describe to each other the basic procedures for checking for proper fit.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.

- Describe the rating scale used on the skills test.

- Reteach and retest as necessary.

- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.

- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in Job Sheet procedures.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "Industry and Education, 'Hand in Hand,'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Videos

- *C5 Automatic Transmission Operation and Diagnosis*, Ford Service Publications, P.O. Box 07150, Detroit, MI 48207, (800) 782-4356.

Other Media

- "Automatic Transmission Repair Worksheets," ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

UNIT REFERENCES

- Birch, Thomas W. *Automatic Transmissions/Transaxles.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

- Bono, Saverio G. and William J. deKryger. *Auto technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.

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- Duffy, James E. *Modern Automotive Mechanics*. South Holland, IL: Goodheart-Willcox Company, Inc., 1990.

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SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

WRITTEN TEST

OBJECTIVE 1

1. A conventional transmission
2. The drive shaft
3. In the rear of the vehicle; by the drive shaft
4. The driveline transmits torque from the transmission output shaft to the driving wheels
5. Because weight is distributed more evenly from front to rear of vehicle

OBJECTIVE 2

1. Lower rod
2. Lock screw
3. Clamp
4. Swivel
5. Clip
6. Upper rod
7. Button assembly
8. Torque shaft assembly
9. Actuator assembly

OBJECTIVE 3

1. Front rod
2. Torque shaft assembly
3. Bushing
4. Torque shaft bracket
5. Clip
6. Rear rod
7. Adjustment swivel
8. Lock screw

OBJECTIVE 4

1. Signals engine load to the transmission

2. Transmits driver's vehicle direction and gear selection commands to the manual control valve

3. Permits driver to obtain a downshift

4. Prevents engine from cranking in any gear but neutral or park; on transmissions equipped with electronically controlled converter clutches, it also sends a signal to the computer and may also control the reverse light switch

5. Controls shift points by sending vacuum signal to the transmission to produce throttle valve pressure signal on some vehicles equipped with a diesel engine

OBJECTIVE 5

Throttle valve linkage

Answer should include any three of the following:

- Shift points too high: overly sensitive downshifts; excessively firm, harsh shifts
- Shift points too low: late or no downshifts; soft, mushy shifts
- Erratic, irregular shifts (sticky or binding linkage)
- Clutch band slippage

Manual shift linkage

Answer should include any four of the following:

- Misdirected oil pressure
- Possible lockup of wrong components
- Creep from partially applied clutch
- Overheating and burnout
- Transmission detents misaligned relative to gear-shift pointer
- Selector-lever slippage

Kickdown linkage

Answer should include any two of the following:

- Over-revving
- Engine failure (due to over-revving)
- No kickdown

Neutral safety switch

- Starter engages in drive or reverse position

OBJECTIVE 6

1. Butt-joint
2. Gasket
3. Gasket compressibility
4. Hard gasket
5. Hook joint
6. metal-clad seal
7. O-ring
8. RTV sealant
9. Scarf-cut
10. Seal
11. Soft gasket

OBJECTIVE 7

The student must correctly label the bushings, thrust bearings, and thrust washers displayed.

OBJECTIVE 8

1. To allow metal parts to expand without binding as the transmission reaches operating temperatures
2. To keep sealing rings in proper location and prevent bearing damage or failure
3. To retain lubrication oil

OBJECTIVE 9

1. To prevent loss of hydraulic pressure when the transmission is cold
2. To prevent the transmission from seizing up when the transmission warms up

OBJECTIVES 10-12

Evaluated on Job Sheets 1-3.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) Automatic Transmission/Transaxle Specialist

UNIT NUMBER AND TITLE – 3 – Servicing Rear-Wheel Drive Transmissions

TOTAL NUMBER OF TEST QUESTIONS 63

TOTAL NUMBER OF BASIC SKILL QUESTIONS 10

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-5	W
2	1-9	X
3	1-8	X
4	1-5	W
5	1-3, 1-4, 1-2, 1	X
6	1-11	X
7	1-10	X
8	1-3	X
9	1-2	X
10-12	Evaluated on JS 1-3	

INSTRUCTOR'S GUIDE

SERVICING TORQUE CONVERTER AND OIL PUMP

4

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the pages in their textbooks on torque converters and on measuring cooler flow rate and torque converter end play.

Writing

R Have students write the assigned process outline.

O Have selected students read their process outlines to the class. Allow the class to critique the processes and to ask questions of the reader.

O Have a student read aloud the introduction to the unit.

O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Describe the primary functions of the torque converter.

R Have students read Information Sheet material.

OBJECTIVE 2

Label the components of a cut-away view of a lockup torque converter assembly.

R Have students study the illustrations.

R Use Transparency Master 1 to illustrate the components of a typical torque converter assembly.

O Show students an actual torque converter, both assembled on a vehicle and disassembled on the bench.

O Pair students or divide students into teams and have them quiz each other on the parts of a torque converter assembly.

OBJECTIVE 3

Match torque converter components with their descriptions/functions.

O Pair students or divide students into teams and have them quiz each other on the functions of torque converter components.

OBJECTIVE 4 **List advantages of the torque converter.**

O Call on students to read this section of the Information Sheet aloud. Explain the "how" of each advantage that the student reads.

OBJECTIVE 5 **Describe conventional and lockup torque converters.**

O Show students examples of conventional and lockup torque converters.

OBJECTIVE 6 **List the advantages of a lockup torque converter over a conventional torque converter.**

O Call on students to read this section of the Information Sheet aloud. Explain the "how" of each advantage that the student reads.

OBJECTIVE 7 **Explain the advantages of the piston lockup-converter clutch over the centrifugal lockup-converter clutch.**

O Call on students to read this section of the Information Sheet aloud. Explain the "how" of each advantage that the student reads.

OBJECTIVE 8 **Identify the three types of commonly used oil pumps.**

R Have students study the illustrations of the different kinds of oil pumps.

R Use Transparency Masters 2 - 4 to illustrate the differences and similarities among the three oil pumps.

O Pair students or divide students into teams and have them quiz each other on the similarities and differences among the three oil pumps.

OBJECTIVE 9 **State the functions of the transmission oil pump.**

O Call on students to read aloud the functions of a transmission oil pump.

OBJECTIVE 10

Label the parts of a variable-output, vane-type oil pump.

R Have students study the illustration of a variable-output, vane-type oil pump in the Information Sheet.

R Use Transparency Master 2 to illustrate the parts of a variable-output, vane-type oil pump.

O Pair students or divide students into teams and have them quiz each other on the components of a variable-output, vane-type oil pump.

OBJECTIVE 11

State indications of possible torque converter problems.

R Describe each indication.

OBJECTIVE 12

Measure torque converter endplay and check for interference. (Job Sheet 1)

R Show students how to use any required specialty tools.

R Have students locate each procedure in the service manual for the make and model vehicle they are servicing.

O Have a student read aloud the introduction.

O Have a student, or students, read aloud any Job Sheet cautions.

OBJECTIVE 13

Inspect oil pump assembly. (Job Sheet 2)

See Objective 12.

OBJECTIVE 14

Flush torque converter. (Job Sheet 3)

R Show students how to use a torque converter flushing machine.

See Objective 12.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.

- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.

- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.

- Describe the rating scale used on the skills test.

- Reteach and retest as necessary.

- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.

- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in Job Sheet procedures.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "Industry and Education, 'Hand in Hand.'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Other Media

- *Automatic Transmission Repair Worksheets*. ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

UNIT REFERENCES

- Birch, Thomas W. *Automatic Transmissions/Transaxles*. Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.

- Bono, Saverio G. and William J. deKryger. *Auto Technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.

- Chek-Chart Publications. Kok, Janette E., ed. *Automatic Transmissions and Transaxles: Classroom Manual*, 2nd ed. New York, NY: Harper & Row Publishers, 1989.

- Chek-Chart Publications. Kok, Janette E., ed. *Automatic Transmissions and Transaxles: Shop Manual*, 2nd ed. New York, NY: Harper & Row Publishers, 1989.

- Duffy, James E. *Modern Automotive Mechanics*. South Holland, IL: Goodheart-Willcox Company, Inc., 1990.

- Flaherty, John. *Automotive Automatic Transmissions and Transaxles Shop Manual*. Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Co., 1992.

- Hydra-Matic. *Understanding the Automatic Transmission*. Ypsilanti, MI: General Motors Corporation, 1986.

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- Stockel, Martin W. and Martin T. Stockel. *Auto Service and Repair*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1989.

- White, John H. *Automatic Transmissions*. Albany, NY: Delmar Publishers, Inc., 1990.

ANSWERS

SERVICING TORQUE CONVERTER AND OIL PUMP

4

WRITTEN TEST

OBJECTIVE 1

Answer should include the following:

1. Acts as a fluid coupling that smoothly transmits engine torque to the transmission gear train
2. Multiplies torque from the engine to the transmission
3. Provides a mechanical (or direct drive) link from the engine to the transmission with the use of a torque converter clutch (TCC)

OBJECTIVE 2

1. Converter cover
2. Impeller
3. Turbine
4. Reactor (Stator)
5. Piston plate clutch and damper assembly
6. Thrust washers
7. Roller bearing
8. Turbine shaft

OBJECTIVE 3

1. G
2. E
3. C
4. D
5. E
6. F
7. A
8. B
9. F
10. G
11. D
12. A
13. B
14. C

OBJECTIVE 4

- Smooths out the transfer of engine torque to the transmission
- Acts as a hydraulic shock absorber to the driveline while loading and unloading stresses are developed during gear-ratio changes
- Acts as a cushion between the engine and transmission as a result of unfavorable driving conditions such as emergency stops
- Provides a variety of torque and speed ratios
- Dampens vibrations

OBJECTIVE 5

Answer should include the following:

1. Conventional
    - Is considered a three-element, two-stage unit
    - Was the fluid clutch used to transfer engine torque in automobiles and light trucks until the 1970s
2. Lockup
    - Is usually considered a four-element, three-stage unit
    - Comes in two types: centrifugal and piston

OBJECTIVE 6

- Eliminates slippage between the impeller and turbine at the coupling stage of operation in a conventional converter
- Improves fuel economy
- Reduces torque converter operational heat

OBJECTIVE 7

- The piston clutch is operated by hydraulic valve action (which is controlled by computer), whereas the centrifugal clutch is operated by turbine speed.

- Due to close computer monitoring of systems information, piston clutch engagement takes place at exactly the right time as it relates to engine operation.

- The piston clutch has fewer parts to malfunction.

- The piston clutch is less expensive.

OBJECTIVE 8

1. Gear-type oil pump
2. Variable-output, vane-type oil pump
3. Rotor-type oil pump

OBJECTIVE 9

- Produces pressure to operate clutches, bands, and gearsets

- Lubricates transmission's moving parts

- Keeps torque converter filled with oil for proper operation

- Circulates oil through transmission and cooling tank (radiator) to transfer heat

- Operates hydraulic valves in the transmission

OBJECTIVE 10

1. Pump cover
2. Rotor
3. Pump vanes
4. Pump vane ring
5. Oil seal ring
6. Pump slide
7. Oil pump body

OBJECTIVE 11

Answer should include any three of the following:

- Slow acceleration from a standstill
- Restricted engine rpm and vehicle speed
- Overheated transmission
- Fluid leakage

OBJECTIVES 12-14

Evaluated on Job Sheets 1-3.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) Automatic Transmission/Transaxle Specialist

UNIT NUMBER AND TITLE — 4 — Servicing Torque Converter and Oil Pump

TOTAL NUMBER OF TEST QUESTIONS 57

TOTAL NUMBER OF BASIC SKILL QUESTIONS 9

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-3	W
2	1-8	X
3	1-14	X
4	1-5	X
5	1-2	W
6	1-3	X
7	1-4	W
8	1-3	X
9	1-5	X
10	1-7	X
11	1-3	X
12-14	Evaluated on JS 1-3	

INSTRUCTOR'S GUIDE

SERVICING GEAR TRAIN/GEARSETS

5

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible Handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the material in their textbooks about gear trains/gearsets. Encourage students to study the electrical and solenoid diagrams, and be prepared to orally explain how electronic controls are used to control transmission shifts.

Writing

R Have students write a paragraph in which they discuss the functions and basic operation of a simple planetary gearset.

R Guide students to appropriate resource materials.

O Have students give brief oral reports (based on their written paragraphs) to the class.

O Have a student read aloud the introduction to the unit.

O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Match types of gears and gearsets with their characteristics.

R Display the different types of gears and gearsets.

O Make (or have students make) a display of the various gears used in automatic transmissions/transaxles.

O Have students quiz each other on the functions of the various gears/gearsets.

OBJECTIVE 2

Label the parts of a simple planetary gearset.

R Have students study the illustration of a simple planetary gearset.

R Use Transparency Master 1 to illustrate the parts of a simple planetary gearset.

O Show students an example of a simple planetary gearset.

OBJECTIVE 3

Explain planetary gearset power flow.

R Review the definitions of the terms in the "Words You Should Know" box.

R Use Transparency Master 2 to explain planetary gearset power flow.

O Have students quiz each other on the various gearset positions.

O To help students remember the results of simple planetary gearset combinations, tell them to ask themselves what the planet carrier is doing.

- If the planetary carrier provides input, the gearset produces overdrive.
- If the planet carrier provides output, the gearset produces forward reduction.
- If the planet carrier is held, the gearset produces reverse.
- When nothing is held, the gearset produces neutral.

O Reinforce this information by writing the following on the chalkboard:

PLANETARY CARRIER
input = overdrive
output = forward reduction
held = reverse
nothing held = neutral

OBJECTIVE 4

Label the parts of a typical planetary gear train assembly.

R Have students study the illustration of the typical planetary gear train assembly.

R Use Transparency Master 3 to illustrate the typical components of a gear train assembly.

O Show students an example of gear train assemblies.

OBJECTIVE 5

State the purposes of holes in shafts.

O Show or explain how oil is delivered to the various clutch packs.

OBJECTIVE 6

State reasons for replacing oil delivery seal rings.

R Review the definitions of the terms in the "Words You Should Know" box.

O Show students examples of cracked and damaged seals.

OBJECTIVE 7

State reasons for replacing bushings.

O Show students examples of dry or worn bushings and examples of damaged shafts.

OBJECTIVE 8

Label the parts of a parking pawl assembly.

R Have students study the illustration of the parking pawl assembly.

R Use Transparency Master 4 to illustrate the typical components of a parking pawl assembly.

O Show students examples of parking pawl assemblies.

OBJECTIVE 9

Disassemble, inspect, and reassemble planetary gear assemblies. (Job Sheet 1)

R Walk through each Job Sheet with the students before assigning it, demonstrating appropriate techniques, suggesting stepsavers, and stressing safety.

R Show students how to identify worn or damaged gear train/gearset parts.

R Show students how to use specialty bushing removal and replacement tools and any other required specialty tools.

R Have students locate each procedure in the service manual for the make and model vehicle they are servicing.

OBJECTIVE 10

Inspect transmission housing. (Job Sheet 2)

See Objective 9.

OBJECTIVE 11

Remove and inspect shafts. (Job Sheet 3)

See Objective 9.

OBJECTIVE 12

Remove and replace oil delivery seal rings. (Job Sheet 4)

See Objective 9.

OBJECTIVE 13

Remove, inspect, and replace bushings. (Job Sheet 5)

See Objective 9.

OBJECTIVE 14

Inspect parking pawl assembly. (Job Sheet 6)

See Objective 9.

OBJECTIVE 15

Remove and replace speedometer drive gear, driven gear, and retainers. (Job Sheet 7)

See Objective 9.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.
- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.

- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.
- Describe the rating scale used on the skills test.
- Reteach and retest as necessary.
- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.
- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in job sheet procedures.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "Industry and Education, 'Hand in Hand,'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Other Media

- "Automatic Transmission Repair Worksheets." ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (806) 654-1700.

UNIT REFERENCES

Publications

- Birch, Thomas W. *Automatic Transmissions/Transaxles.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.
- Bono, Saverio G. and William J. deKryger. *Auto Technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.
- Duffy, James E. *Modern Automotive Mechanics.* South Holland, IL: Goodheart-Willcox Company, Inc., 1990.
- Flaherty, John. *Automotive Automatic Transmissions and Transaxles Shop Manual.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Co., 1992.
- Hydra-Matic. *Understanding the Automatic Transmission.* Ypsilanti, MI: General Motors Corporation, 1986.
- *Hydra-Matic 4T60 Technician's Guide.* Ypsilanti, MI: Powertrain Division of General Motors Corporation, July, 1991.
- Kovacik, Robert T. and Saverio G. Bono. *Automatic Transmissions.* Cincinnati, OH: South-Western Publishing Co., 1984.
- Mitchell International, Inc. *Mitchell Automechanics.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1986, 1991.

WRITTEN TEST

OBJECTIVE 1

1. E
2. C
3. H
4. A
5. E
6. D
7. F
8. B
9. E or G
10. I

OBJECTIVE 2

1. Planet carrier
2. Planet gears
3. Sun gear
4. Internal ring gear

OBJECTIVE 3

1. Reverse
2. Direct drive
3. Forward reduction
4. Overdrive

OBJECTIVE 4

1. Output shaft
2. Front planetary gearset
3. Front ring gear assembly
4. Sun gear
5. Driving shell
6. Thrust plate
7. Snap ring
8. Thrust washer
9. Rear planetary gearset
10. Rear ring gear assembly
11. Low/reverse drum

OBJECTIVE 5

- To provide oil to the various clutch packs
- To provide oil to the various gearsets
- To provide oil to the various bushings

OBJECTIVE 6

- Unwanted internal or external leakage
- Cracks
- Deterioration or other damage

OBJECTIVE 7

- Wear
- Scoring
- Damaged shaft
- Lack of lubrication

OBJECTIVE 8

1. Pawl
2. Spring
3. Shaft
4. Spring

OBJECTIVES 9-15

Evaluated on Job Sheets 1-7.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) Automatic Transmission/Transaxle Specialist

UNIT NUMBER AND TITLE — 5 — Servicing Gear Train/Gearsets

TOTAL NUMBER OF TEST QUESTIONS 43

TOTAL NUMBER OF BASIC SKILL QUESTIONS 0

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-10	X
2	1-4	X
3	1-4	X
4	1-11	X
5	1-3	X
6	1-3	X
7	1-4	X
8	1-4	X
9-15	Evaluated on JS 1-7	

INSTRUCTOR'S GUIDE

SERVICING FRICTION UNITS AND COOLER

6

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the pages in their textbooks on automatic transmission friction units and the sections in their vehicle manuals on the multiple-disc clutch assembly, sprag and roller clutches, and bands and drums.

Writing

R Have students write the assigned paragraphs.

O Have selected students read their explanations to the class. Allow the class to critique the explanations and to ask questions of the reader.

O Have a student read aloud the introduction to the unit.

O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Label the parts of a multiple-disc clutch assembly.

R Have students study the exploded view of the clutch assembly.

R Use Transparency Master 1 to illustrate the parts of a clutch assembly.

O Have students locate the clutch assembly on the transmission or vehicle they will be servicing.

O Pair students or divide students into teams and have them quiz each other on those components of a variable output, vane-type oil pump.

OBJECTIVE 2

State the functions of clutch assembly components.

R Have students read Information Sheet material.

OBJECTIVE 3

Describe types of piston return spring arrangements.

R Use Transparency Master 2 to illustrate the different types of clutch return spring arrangements.

O Have students locate the clutch return spring on the transmission or vehicle they will be servicing.

OBJECTIVE 4

Explain clutch operation.

- R Create a diagram to visually illustrate clutch operation.

OBJECTIVE 5

Explain the importance of clutch pack clearances.

- O Have students practice measuring clearances with a feeler gauge.

OBJECTIVE 6

Label the parts of a sprag clutch.

- R Have students study the simplified view of the sprag clutch.
- R Use Transparency Master 3 to illustrate the parts of a sprag clutch.
- O If applicable, have students locate a sprag clutch on the transmission or vehicle they will be servicing.

OBJECTIVE 7

Label the parts of a roller clutch.

- R Have students study the simplified view of the roller clutch.
- R Use Transparency Master 4 to illustrate the parts of a roller clutch.
- O If applicable, have students locate a roller clutch on the transmission or vehicle they will be servicing.

OBJECTIVE 8

Explain how sprag and roller clutches work.

- O Use Transparency Masters 3 and 4 to illustrate your explanation.

OBJECTIVE 9

Label the parts of a typical band/servo assembly.

- R Display a typical band and servo assembly or its components.
- O Have students locate a band and servo assembly on the transmission or vehicle they will be servicing.

OBJECTIVE 10

State the functions of band and servo components.

- R Have students read Information Sheet material.

OBJECTIVE 11

State the functions of internal and external coolers.

O Show students examples of internal and external coolers.

OBJECTIVE 12

Distinguish between descriptions of internal and external coolers.

R Have students read Information Sheet material.

R Use Transparency Master 5 to illustrate your discussion.

OBJECTIVE 13

Disassemble, inspect, replace, and reassemble a multiple-disc clutch assembly. (Job Sheet 1)

R Walk through each Job Sheet with the students before assigning it, demonstrating appropriate techniques, suggesting stepsavers, and stressing safety.

R Show students how to use a transmission jack.

R Review methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

R Show students how to handle clutch pack components.

R Show students how to use specialty removal and replacement tools and any other required specialty tools.

R Have students locate each procedure in the service manual for the make and model vehicle they are servicing.

OBJECTIVE 14

Measure and adjust clutch pack clearance. (Job Sheet 2)

See Objective 11.

OBJECTIVE 15

Air test clutch pack and internal servo assemblies. (Job Sheet 3)

See Objective 11.

OBJECTIVE 16

Inspect and replace sprag and roller clutches. (Job Sheet 4)

See Objective 11.

OBJECTIVE 17

Inspect and adjust bands and replace or refinish drums. (Job Sheet 5)

See Objective 11.

OBJECTIVE 18

Leak test and service cooler and lines. (Job Sheet 6)

See Objective 11.

OBJECTIVE 19

Measure cooler flow rate. (Job Sheet 7)

See Objective 11.

OBJECTIVE 20

Reassemble transmission. (Job Sheet 8)

See Objective 11.

OBJECTIVE 21

Reinstall and adjust transmission. (Job Sheet 9)

See Objective 11.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.
- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.
- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.
- Describe the rating scale used on the skills test.
- Reteach and retest as necessary.
- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.
- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in Job Sheet procedures.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "*Industry and Education*, 'Hand in Hand.'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Other Media

- "Automatic Transmission Repair Worksheets." ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

UNIT REFERENCES

Publications

- Chek-Chart Publications. *Automatic Transmissions and Transaxles: Classroom Manual*, 2nd ed. New York, NY: Harper & Row Publishers, 1989.
- Chek-Chart Publications. *Automatic Transmissions and Transaxles: Shop Manual*, 2nd ed. New York, NY: Harper & Row Publishers, 1989.
- Duffy, James E. *Modern Automotive Mechanics.* South Holland, IL: Goodheart-Willcox Company, Inc., 1990.
- Flaherty, John. *Automotive Automatic Transmissions and Transaxles Shop Manual.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Co., 1992.
- Kovacik, Robert T. and Saverio G. Bono. *Automatic Transmissions.* Cincinnati, OH: South-Western Publishing Co., 1984.
- Mitchell International, Inc. *Mitchell Automechanics.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1991.
- Stockel, Martin W. and Martin T. Stockel. *Auto Service and Repair.* South Holland, IL: Goodheart-Willcox Company, Inc., 1989.
- White, John H. *Automatic Transmissions.* Albany, NY: Delmar Publishers, Inc., 1990.

ANSWERS

SERVICING FRICTION UNITS AND COOLER

6

WRITTEN TEST

OBJECTIVE 1

1. Hub
2. Clutch plates (driven)
3. Spring retainer
4. Piston
5. Piston seal ring (outer)
6. Hub (cylinder)
7. Piston seal ring (inner)
8. Clutch release spring
9. Snap ring
10. Friction discs (driving)
11. Pressure plate
12. Snap ring (waved)
13. Drum for another clutch assembly

OBJECTIVE 2

1. Enclosing components of clutch assembly
2. Engaging driving disc teeth
3. Meshing with splines on clutch assembly hub and driving clutch plates to transmit engine torque
4. Turning (being driven) to transmit engine torque when clutch is activated
5. Forcing clutch plates against the pressure plate so that discs, plates, input shaft, and clutch drum rotate as a unit

6. Thick steel plate held into clutch drum by snap ring; provides opposing reaction to movement of piston, thereby compressing driven friction plates between driving steel units

7. Overcoming reduced fluid pressure in the clutch drum and returning piston to released position after clutch disengagement

8. Retaining fluid pressures used to stroke the clutch apply piston

9. Holding pressure plate in clutch drum

OBJECTIVE 3

1. One large, coiled spring

2. Several coil springs that operate the same as a single coil spring

3. Spring with several levers projecting from center to outside; levers multiply piston engagement force on clutch pack to reduce chance of clutch slippage; found mostly in rear clutches

4. Newest and smallest of piston return springs, the wave washer simply flattens and stores tension when the clutch engages and releases this tension to move the clutch piston to the disengaged position when the clutch disengages

OBJECTIVE 4

Disengaged

1. No oil pressure enters the drum.

2. Spring(s) holds piston away from clutch discs/plates.

3. Input shaft turns clutch hub and driving discs, but driven plates and drum remain stationary.

Engaged

1. Oil pressure is routed to clutch drum.

2. Oil pressure forces piston into clutch discs, locking them together, forcing them into pressure plate, and thus transferring power through clutch assembly to the drum.

3. When clutch is released, oil pressure decreases, allowing piston return spring(s) to release its tension and push clutch plates and discs apart.

OBJECTIVE 5

1. Friction disc to clutch plate disengaged clearance is generally a mere 0.010 inch per friction side.
2. Both plates and friction discs must be perfectly true; a warped or bent clutch plate reduces clutch pack life.
3. When the clutch pack is too tight, clutches can bind and wear out prematurely.
4. Excess clearance causes rough engagements, engine flare-ups, and premature wear.
5. Manufacturers use different methods of obtaining clutch pack clearances; it is important to pay close attention to the method specified by the manufacturer.

OBJECTIVE 6

1. Sprags
2. Hub
3. Drum

OBJECTIVE 7

1. Hub
2. Drum
3. Rollers
4. Springs
5. Unlocked

OBJECTIVE 8

Sprag clutch

1. The sprag clutch allows one-way hub rotation at all times.
2. When the clutch hub rotates clockwise, the sprags tilt and open a space between themselves, the hub, and the drum.
3. This action unlocks the clutch and allows the hub to freewheel.
4. When the drum is held, the moment the hub rotates counterclockwise, the sprags tilt the other way and wedge between the hub and drum, locking the clutch.

Roller clutch

1. The roller clutch allows one-way hub rotation at all times.
2. When the clutch hub rotates clockwise, the rollers move toward the large ends of the cam-cut drum pockets, compressing the springs.
3. This action unlocks the clutch and allows the hub to freewheel.
4. When the clutch drum is held, the moment the hub rotates counterclockwise, the rollers (with the help of released spring tension) wedge into the small ends of the drum pockets, locking the clutch.

OBJECTIVE 9

The following parts must be identified in the properly numbered blanks:

- Anchor pin
- Brake band
- Band actuating rod
- Band release spring
- Damping spring
- Piston seal
- Snap ring
- Servo piston
- Servo pressure chamber
- Band adjusting screw
- Locknut
- Servo cover
- Automatic transmission case

OBJECTIVE 10

1. Stopping drum rotation
2. Providing friction

3. Transferring force to activating rod
4. Pushing on band to squeeze it inward on drum
5. Adjusting band-to-drum clearance
6. Preventing fluid leakage around the servo piston and cylinder
7. Holding the piston in its cylinder

OBJECTIVE 11	Internal and external coolers prevent automatic transmission damage by cooling transmission fluid that has been heated by the actions of the torque converter, gears, and shafts; and return cooled transmission fluid to the transmission.
OBJECTIVE 12	2
OBJECTIVES 13-21	Evaluated on Job Sheets 1 - 9.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) Automatic Transmission/Transaxle Specialist

UNIT NUMBER AND TITLE — 6 — Servicing Friction Units and Cooler

TOTAL NUMBER OF TEST QUESTIONS 76

TOTAL NUMBER OF BASIC SKILL QUESTIONS 24

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-13	X
2	1-9	X
3	1-4	W
4	1-3, 1-3	W
5	1-5	W
6	1-3	X
7	1-5	X
8	1-4, 1-4	W
9	1-13	X
10	1-7	X
11	1	W
12	1-2	X
13-21	Evaluated on JS 1-9	

INSTRUCTOR'S GUIDE

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the pages in their textbooks on front-wheel drive transaxles and the sections in their vehicle manuals on the removal, disassembly, and cleaning of front-wheel drive transaxles.

Writing

R Have students write the assigned sentences.

O Have selected students read their sentences to the class. Allow the class to comment and ask questions of the reader.

O Have a student read aloud the introduction to the unit.

O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

O Have students give brief reports to the class on the type of transmission (RWD transmission/FWD transaxle) they have (or would like) in their vehicles. Ask the students to elaborate on whether the type of drive/transmission entered into their decision to select their particular vehicle.

O Show video series *Front Wheel Drive Explained.*

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1

Answer questions about the characteristics of a front-wheel drive automatic transmission/transaxle.

R Review the definitions of the terms in the "Words You Should Know" box.

R Have students study the illustration of the front-wheel drive automatic transaxle.

R Use Transparency Master 1 to illustrate and discuss front-wheel drive design.

O Check under the hood of different makes and models of vehicles in your shop. Note the engine and transaxle configuration and position.

OBJECTIVE 2 **Label the parts of a typical gearshift linkage on a front-wheel drive transaxle.**

R Have students study the illustration of the typical gearshift linkage arrangement.

R Use Transparency Master 2 to illustrate and discuss the basic components of a typical FWD gearshift linkage.

O Show students examples of FWD gearshift linkage components.

O Have students locate the gearshift linkage on several different makes and models of front-wheel drive vehicles.

O Have students quiz each other over gearshift linkage component names.

OBJECTIVE 3 **Describe the functions of various types of automatic transaxle linkages and controls.**

R Provide examples and analogies and explain functions in more detail.

R Show students examples of the various switches and linkages.

O Call on different students to read aloud the functions of the automatic transaxle linkages and controls.

O Have students locate the various linkages and controls on a front-wheel drive vehicle.

O Have students quiz each other on the functions of the automatic transaxle linkages and controls listed.

OBJECTIVE 4 **State the function of the transaxle drive link assembly.**

R Provide examples and analogies and explain functions in more detail.

OBJECTIVE 5 **Label the parts of a transaxle drive link assembly.**

R Have students study the illustration of the transaxle drive link assembly.

R Use Transparency Master 3 to illustrate and discuss the components of a typical transaxle drive link assembly.

O Have students locate drive link assembly components on various FWD shop vehicles.

OBJECTIVE 6 **Identify wear points of a transaxle drive link assembly.**

R Have students study the transaxle drive link assembly wear points illustrated.

R Use Transparency Master 4 to highlight and discuss the transaxle drive link assembly wear points.

O Have students locate drive link assembly wear points on various FWD shop vehicles.

OBJECTIVE 7 **Label the parts of a typical FWD axle shaft assembly.**

R Have students study the FWD axle shaft assembly illustrated.

R Use Transparency Master 5 to illustrate the components of a typical FWD axle shaft assembly.

O Have students locate the axle shaft assembly on various FWD shop vehicles.

OBJECTIVE 8 **Label the parts of a typical final drive and differential assembly.**

R Have students study the illustration of the transaxle final drive assembly.

R Use Transparency Master 6 to illustrate and discuss the components of a typical transaxle final drive and differential assembly.

O Have students locate the transaxle final drive and differential assembly on various FWD shop vehicles.

OBJECTIVE 9 **Identify final drive arrangements and gear types.**

R Review the definitions of the terms in the "Words You Should Know" box.

R Have students study the arrangements and gears illustrated.

R Use Transparency Masters 7-9 to illustrate the various final drive arrangements and gear types.

- R Show students examples of the various final drive arrangements and gear types.
- O Have students locate and identify the final drive on various makes and models of FWD vehicles.

OBJECTIVE 10 **Replace external seals and gaskets. (Job Sheet 1)**

- R Show students how to locate the external seals and gaskets on a front-wheel drive vehicle.
- R Have students locate the flexplate, drive link and final drive assemblies on the vehicles on which they will be working.
- R Show students how to use a transmission jack.
- R Walk through each Job Sheet with the students before assigning it, demonstrating appropriate techniques, suggesting stepsavers, and stressing safety.
- R Show students how to identify worn or damaged gear train/gearset parts.
- R Show students how to use any required specialty tools.
- R Have students locate each procedure in the service manual for the make and model vehicle they are servicing.
- O Have a student read aloud the Job Sheet introductions.

OBJECTIVE 11 **Remove transaxle. (Job Sheet 2)**

See Objective 10.

OBJECTIVE 12 **Disassemble and clean transaxle. (Job Sheet 3)**

See Objective 10.

OBJECTIVE 13 **Inspect converter flexplate assembly. (Job Sheet 4)**

See Objective 10.

OBJECTIVE 14 **Inspect transaxle drive link assembly. (Job Sheet 5)**

See Objective 10.

OBJECTIVE 15

Inspect transaxle final drive components. (Job Sheet 6)

See Objective 10.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.

- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.

- Describe the rating scale used on the skills test.

- Reteach and retest as necessary.

- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.

- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in Job Sheet procedures.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "Industry and Education, 'Hand in Hand,'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Videos

- Slides-on-Video Series *Front Wheel Drive Explained: Basic Construction and Operation of Front Wheel Drives* (10 min.), and *Power Flow Maintenance and Engine Removal and Replacement* (18 min.). Bergwall Productions, Inc., 540 Baltimore Pike, Chadds Ford, PA 19317-9304, (800) 645-3565.

- *C5 Automatic Transmission Operation and Diagnosis*, Ford Service Publications, P.O. Box 07150, Detroit, MI 48207, (800) 782-4356.

Other Media

- *Automatic Transmission Repair Worksheets*, ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003 (805) 654-1700.

UNIT REFERENCES

- Birch, Thomas W. *Automatic Transmissions/Transaxles.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Company, 1991.
- Bono, Saverio G. and William J. deKryger. *Auto Technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.
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- Flaherty, John. *Automotive Automatic Transmissions and Transaxles Shop Manual.* Westerville, OH: Glencoe Division of Macmillan/McGraw-Hill Publishing Co., 1992.
- Hydra-Matic. *Understanding the Automatic Transmission.* Ypsilanti, MI: General Motors Corporation, 1986.
- Kovacik, Robert T. and Saverio G. Bono. *Automatic Transmissions.* Cincinnati, OH: South-Western Publishing Co., 1984.
- Mitchell International, Inc. *Automatic Transmissions and Transaxles: Fundamentals and Systems.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1989.
- *1991-92 Transmission Service & Repair: Domestic Cars, Light Trucks & Vans.* San Diego, CA: Mitchell International, Inc., 1992.
- White, John H. *Automatic Transmissions.* Albany, NY: Delmar Publishers, Inc., 1990.

WRITTEN TEST

OBJECTIVE 1

1. By two driving axles (halfshafts)

2. Transaxle output shaft and final drive ring gear

3. The drive ring gear drives the pinion gears against side gears splined to the front drive axles.

4. Lightweight and compact

5. Improved traction and increased fuel economy

OBJECTIVE 2

1. Clamp
2. Lock bolt
3. Cable assembly
4. Dash panel
5. Gearshift bracket assembly
6. Floor pan
7. Transaxle
8. Bracket

OBJECTIVE 3

1. Signals engine load to the transaxle

2. Transmits driver's vehicle direction and gear selection commands to the manual control valve

3. Permits driver to obtain a downshift

4. Prevents engine from cranking in any gear but neutral or park; on transaxles equipped with electronically controlled converter clutches, it also sends a signal to the computer

5. Controls shift points by sending vacuum signal to the transaxle on some vehicles equipped with a diesel engine

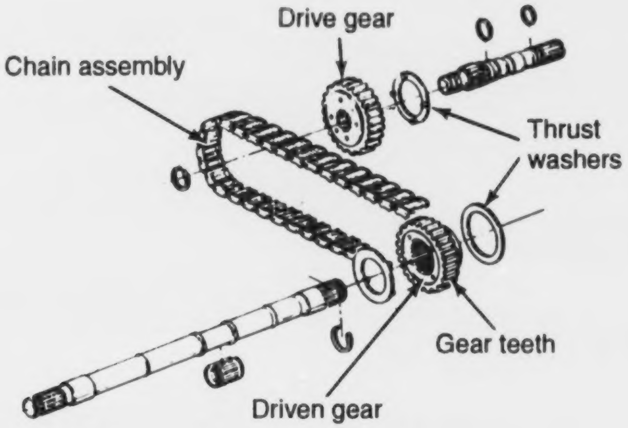
OBJECTIVE 4

Connecting the engine to the transmission

OBJECTIVE 5

1. Output shaft
2. Drive link chain assembly
3. Drive gear
4. Drive sprocket
5. Turbine shaft
6. Thrust washer
7. Driven sprocket
8. Driven gear

OBJECTIVE 6



OBJECTIVE 7

1. Outer housing
2. Cross (driver)
3. Ball
4. Cage
5. Constant velocity (CV) boot
6. Boot clamp
7. Damper weight
8. Axle shaft
9. Tripod joint
10. Boot clamp
11. Collar
12. Inner housing

OBJECTIVE 8

1. Final drive sun gear shaft
2. Final drive internal gear
3. Bearing assembly
4. Parking gear
5. Final drive sun gear
6. Thrust bearing
7. Differential and final drive carrier
8. Carrier washer
9. Bearing assembly
10. Side gears
11. Differential pinions
12. Final drive pinion

OBJECTIVE 9	1. Bevel gear final drive 2. Helical-cut final drive gearset 3. Final drive planetary gearset and differential assembly
OBJECTIVES 10-15	Evaluated on Job Sheets 1-6.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) **Automatic Transmission/Transaxle Specialist**

UNIT NUMBER AND TITLE **– 7 – Servicing Front-Wheel Drive Transaxles**

TOTAL NUMBER OF TEST QUESTIONS **59**

TOTAL NUMBER OF BASIC SKILL QUESTIONS **10**

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	**1-5**	**W**
2	**1-8**	**X**
3	**1-5**	**W**
4	**1**	**X**
5	**1-8**	**X**
6	**1-5**	**X**
7	**1-12**	**X**
8	**1-12**	**X**
9	**1-3**	**X**
10-15	**Evaluated on JS 1-6**	

INSTRUCTOR'S GUIDE

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the material in their textbooks dealing with diagnosing problems with automatic transmissions/transaxles.

O Have a student read aloud the introduction to the unit.

O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

Writing

R Have students refer to the color-coded oil pressure circuits in their textbook or a service manual. Have students choose a circuit, and write several paragraphs describing the sequence and purpose of that circuit's flow of oil pressure in an automatic transmission/ transaxle.

R Guide students to appropriate resource materials.

O Have students give brief oral reports (based on their paragraphs) to the class.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

OBJECTIVE 1 **List the basic steps in automatic transmission diagnosis.**

O Call on students to read aloud from the Information Sheet.

O Discuss the importance of following the steps in order.

OBJECTIVE 2 **Read an oil circuit diagram. (Assignment Sheet 1)**

R See the general instructions for all Assignment Sheets.

O Call on students to read aloud Assignment Sheet introductions and instructions.

O Have students complete a blank diagram for additional gears, such as D-1, D-2, D-3, Reverse, Manual Low, and Manual Second.

OBJECTIVE 3 **Read application/range reference charts. (Assignment Sheet 2)**

See Objective 2.

OBJECTIVE 4 **Read troubleshooting charts. (Assignment Sheet 3)**

See Objective 2.

OBJECTIVE 5 **Read an electrical circuit test chart. (Assignment Sheet 4)**

See Objective 2.

OBJECTIVE 6 **Distinguish among the purposes of road tests, stall tests, control pressure tests, and lock-up converter system tests.**

R Describe general symptoms revealed by each of the transmission system tests.

O Call on a student or students to read aloud Information Sheet material.

OBJECTIVE 7 **List safety guidelines for performing road tests, stall tests, control pressure tests, and lock-up converter system tests.**

R Explain the reasoning behind each guideline.

O Call on students to read aloud from the Information Sheet.

OBJECTIVE 8 **Perform a stall test. (Job Sheet 1)**

R See the general instructions for all Job Sheets.

R Before assigning the Job Sheet, demonstrate appropriate techniques, suggest stepsavers, and emphasize safety.

R Have students locate each procedure in the service manual for the make and model vehicle they are servicing.

OBJECTIVE 9 **Perform a road test. (Job Sheet 2)**

See Objective 8.

OBJECTIVE 10 **Perform control pressure tests. (Job Sheet 3)**

See Objective 8.

OBJECTIVE 11

Perform lock-up converter system tests. (Job Sheet 4)

See Objective 8.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.

- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.

- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.

- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.

- Describe the rating scale used on the skills test.

- Reteach and retest as necessary.

- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.
- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in Job Sheet procedures.

OPTIONAL RESOURCES

Publications

- *Measuring Learning and Competency Gains: The Pretest/Posttest Approach.* Stillwater, OK: CIMC, Oklahoma Department of Vocational and Technical Education, 1992. For ordering information call 800-522-5810.
- Certification Test Booklet: "Industry and Education, 'Hand in Hand,'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

  ☑ **NOTE:** It is strongly recommended that you obtain copies of this booklet for each student in the class. Assign unit-relevant sections of the test to provide students with ample practice and familiarization with the ASE test format.

Videos

- *The Road Test*

  ☑ **NOTE:** This 1993 VHS cassette is available from Bergwall Productions, Inc., 540 Baltimore Pike, Chadds Ford, PA 19317. Phone 1-800-645-3565.

Other Media

- "Automatic Transmission Repair Worksheets," ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

UNIT REFERENCES

Publications

- *Automatic Transmissions and Transaxles: Fundamentals and Systems.* Englewood Cliffs, NJ: Prentice Hall, 1989.
- *Chilton's Transmission Service Manual: Domestic Cars & Trucks*, Professional Mechanic's Edition. Radnor, PA: Chilton Book Company, 1989.
- *Motor Domestic Transmission Manual*, Professional Service Trade Edition. Troy, MI: Hearst Books/Business Publishing Group, a Division of Hearst Corp., 1990.
- *1991-92 /Transmission Service & Repair: Domestic Cars, Light Trucks & Vans.* San Diego, CA: Mitchell International, 1992.
- *Hydra-Matic 4T60 Technician's Guide.* Ypsilanti, MI: Powertrain Division of General Motors Corporation, July, 1991.
- Kovacik, Robert T. and Saverio G. Bono. *Automatic Transmissions.* Cincinnati, OH: South-Western Publishing Co., 1984.
- Mitchell International, Inc. *Mitchell Automechanics.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1986, 1991.

ANSWERS

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

ASSIGNMENT SHEETS

OBJECTIVE 2

Assignment Sheet 1 — Evaluated by both the student and the instructor against the color illustrations in the appropriate service manual

OBJECTIVE 3

Assignment Sheet 2

1. CL, converter clutch lockup; CU, converter clutch unlock
2. mph (miles per hour)
3. Yes
4. 8 to 13 mph
5. 57 to 62 mph
6. No; 43 to 50 mph
7. 4th to 3rd downshift is within acceptable range of 41 mph to 26 mph; 1st to 2nd upshift is 1 mph over the acceptable range of 33 mph to 47 mph
8. Yes
9. 1,000 rpm and approximately 15 mph
10. Approximately 65 mph
11. Approximately 1500 rpm
12. No. Acceptable range is 24 mph, plus or minus 3 mph.
13. Yes. The acceptable range is 54 mph, plus or minus 5 mph.
14. 23 mph to 26 mph
15. 69 mph to 76 mph
16. The low-int band is probably not applying.

17. The low-one-way clutch is not holding.

18. The overdrive band is not applying.

19. Forward clutch is not applying.

OBJECTIVE 4

Assignment Sheet 3

1. Answer should include any three of the following:
   - shift-lock lever cannot be moved smoothly because of a large amount of play or friction of the shift-lock lever fulcrum pin
   - Poorly adjusted shift-lock cable; considerable elongation of inner cable
   - Poorly adjusted interlock cable
   - Broken or fatigued shift-lock cable return spring (brake pedal side)
   - Interlock cam and interlock lever not sliding smoothly

2. The stop light stays ON.

3. Check the selector lever bracket assembly, apply grease, or replace the assembly

4. Find and follow the service manual Electronic Controls article that deals with the EPC solenoid

5. 9-12 N-m or 7-9 lb-ft

6. Answer should include any four of the following:
   - EPC solenoid inoperative or damaged
   - EED-IV microprocessor inoperative
   - Oil pressure too high or too low
   - 3-4 accumulator piston stuck or damaged
   - 3-4 piston seal missing or damaged
   - 3-4 springs missing or damaged
   - No. 4 and/or No. 12 check ball missing or damaged
   - Accumulator regulator valve stuck, nicked, or damaged

7. Electronic engine control or transaxle electrical system

8. Replace them with appropriate new components

9. Harsh shift from NEUTRAL to DRIVE or from NEUTRAL to REVERSE

10.
- Disconnected or misadjusted TV cable
- Bent or damaged TV link, lever, or bracket assembly
- Stuck or binding TV valve and plunger
- Incorrect governor pressure

OBJECTIVE 5

Assignment Sheet 4

1.
- fuse
- ground
- normally open
- resistor
- coil
- connection
- switch

2.
- brown
- light blue
- tan/black
- purple
- pink/black

3. 15-ampere

4. By providing a ground (circuit 422) to energize the solenoid

5. 1) Vehicle speed must be greater than 24 mph.
   2) Engine must be at normal operating temperature.
   3) Throttle position sensor must remain steady (not change).
   4) Brake switch must be closed.

6. The solenoid or sump overtemperature switch may be faulty

7. Confirming the 12-volt supply as well as the continuity of the circuit

8. Open in circuit 39, TCC brake switch circuit, or adjust switch

9. The brake switch is out of adjustment or faulty, or circuit 422 is shorted to voltage

10. More than 20 ohms; because less resistance will cause a early failure of the ECM driver

11. To determine whether 4th gear switch is functioning properly

12. To determine whether circuit 446 is shorted to ground or whether the problem is in the transmission

WRITTEN TEST

OBJECTIVE 1

Step 1: Verify the problem.

Step 2: Narrow the problem.

Step 3: Perform tests and inspections.

Step 4: Repair the indicated problem, following recommended service procedure, including required adjustments.

Step 5: Verify that the original problem has been solved and that no new ones have been created.

OBJECTIVE 2

Evaluated on Assignment Sheet 1.

OBJECTIVE 3

Evaluated on Assignment Sheet 2.

OBJECTIVE 4

Evaluated on Assignment Sheet 3.

OBJECTIVE 5

Evaluated on Assignment Sheet 4.

OBJECTIVE 6

1. Control pressure test
2. Road test
3. Stall test
4. Lock-up converter system test
5. Control pressure test
6. Stall test
7. Lock-up converter system test
8. Road test

OBJECTIVE 7

1. Any four of the following:

   - Always check the service manual to determine whether a stall test is recommended.
   - To avoid transmission damage, do not hold the throttle open longer than 5 seconds.

- Cool down the transmission by allowing a period of 15 to 30 seconds with transmission in neutral and engine speed at 1,000 rpm between each test.

- If engine speed exceeds maximum specified limits, immediately release the accelerator, as this is an indication of clutch or band slippage.

- Fully apply the service and emergency brakes during this test, and block the drive wheels.

- Be sure that the area in front of the vehicle is clear of obstructions, and do not let anyone stand in front of the vehicle when performing this test.

2. Any four of the following:

   - Perform this test with a helper so that you will not be tempted to try to drive and read or record at the same time. Your helper will record shift speeds and refer to the appropriate charts.

   - Before turning on the engine, spend the necessary time to fasten your seatbelt, adjust mirrors and seat, and familiarize yourself with the vehicle's operating controls.

   - Conduct road test only on isolated roads with little traffic or on vacant parking lots or specifically designated test areas.

   - Drive in a safe manner and only in a manner that is required to check or diagnose proper transmission operation.

   - Avoid jackrabbit starts, hard cornering, or sudden braking.

   - Observe all speed limits and obey all traffic laws.

   - Be extremely careful when backing up; conduct "reverse" tests only on a flat, level road or surface with no dropoffs to the side.

3. Any two of the following:

   - Never go under a vehicle on a hydraulic jack without first placing jack stands under it.

- Enlist a helper to operate the transmission, accelerator, and brake controls inside the vehicle.

- Take extreme care if service manual pressure test procedures or equipment require you to be under the vehicle during this test.

4. Answer should include the following—Always refer to appropriate service manual or service bulletin for specific transmission computer tests.

OBJECTIVE 8	Evaluated on Job Sheet 1.
OBJECTIVE 9	Evaluated on Job Sheet 2.
OBJECTIVE 10	Evaluated on Job Sheet 3.
OBJECTIVE 11	Evaluated on Job Sheet 4.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) **Automatic Transmission/Transaxle Specialist**

UNIT NUMBER AND TITLE — **8** — **Diagnosing General Automatic Transmission/ Transaxle Problems**

TOTAL NUMBER OF TEST QUESTIONS **17**

TOTAL NUMBER OF BASIC SKILL QUESTIONS **0**

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-5	X
2	Evaluated on AS 1	
3	Evaluated on AS 2	
4	Evaluated on AS 3	
5	Evaluated on AS 4	
6	1-8	X
7	1-4	X
8-11	Evaluated on JS 1-4	

INSTRUCTOR'S GUIDE

TESTING RELATED ELECTRONIC COMPONENTS

9

Required Activities and Resources (R)

These are fully integrated components of this CIMC curriculum. They are usually packaged in or with the curriculum and are essential in meeting the learning objectives. To individualize this unit, use the LAP Sheet supplied in your resources.

- Reproducible Handouts and Transparency Masters are included in the Instructor's Resource Package. Handouts should be copied for all students. Transparency Masters should be used to make overhead transparencies for use during instruction. A small copy of each Transparency Master appears in the student's Information Sheets.
- Non-reproducible resources are included in the student's curriculum.

Optional Activities and Resources (O)

These are suggested high-interest activities to help deliver learning objectives to students or to let students achieve objectives in an applied context. Select as many as you wish to use. Some activities use extra resources for further information about unit content. You can make them available in the classroom for in-depth study or optional activities, but their use is not required for meeting CIMC unit objectives.

FOCUS ASSIGNMENTS

Prereading

R Have students read the material in their textbook.

Writing

R Have students write a well-developed paragraph in which they summarize the types of related electronic components and their functions.

O Have selected students read their paragraphs to the class. Allow the class to comment and ask questions of the reader.

O Have a student read aloud the introduction to the unit.

O Read (or have a student read) the unit objective and then the specific objectives. Emphasize how accomplishing the specific objectives leads to meeting the unit objective, and how reaching the unit objective is vital to becoming an automatic transmission/transaxle specialist. Also relate the objective to the introduction and to material previously covered.

GENERAL INSTRUCTIONS

Assignment Sheets

R Review the directions and any specific guidelines.

R Make certain that any needed materials from the Instructor's Resource Package are available.

R Have the students complete the Assignment Sheet. Evaluate each student's performance and provide reteaching and retesting as necessary. Have the students repeat the Assignment Sheet until they achieve mastery.

R Complete each student's Competency Profile.

O Have the students volunteer to read aloud the directions and any special guidelines.

O Return the completed Assignment Sheets to the students so that they may use them for later reference if needed.

Job Sheets

R Review the introduction and evaluation criteria for the Job Sheet. Remind the students that they should not fill in the blanks in the Yes/No columns.

R Review and explain all general guidelines, safety cautions, and warnings.

R Make sure that all tools, equipment, and supplies are available.

R Demonstrate each of the procedures outlined in the Job Sheet.

R Allow the students to practice the Job Sheet skills before skills testing. Coach, correct, and supervise as necessary.

R Have the students complete the Job Sheet. Evaluate each student's performance and provide remediation as necessary. Have the students repeat the Job Sheet until they achieve mastery.

R Complete each student's Competency Profile.

R Return the completed Job Sheets to the students so that they may use them for later reference if needed.

O Have the students volunteer to read aloud the job guidelines, cautions, and warnings.

LAP Sheets

The LAP Sheets are an optional component that can be used to individualize instruction. The following instructions should be followed only if you are using the LAP Sheets.

R Explain the specific procedures to be followed to the students before they begin using the LAP Sheet. Be sure that each student understands the procedures for using the LAP Sheet.

R If you want the student to complete any of the assignments on the LAP Sheet that are labeled optional, assign these to the student. Be sure to provide any needed resources.

INTRODUCTION

O Show the videos *The Automotive Computer: Explaining the Black Box* and *The Automotive Computer: The Computer in Action.* Ask for and answer student questions.

O Assign *Automotive Mechanics GM Computer Command Control* software lessons and quizzes.

O Have students locate electronic control system components on several vehicles of different makes and models.

OBJECTIVE 1

Match computer control system components with their functions.

R Explain the roles of the computer in different transmissions/transaxles and vehicles.

R Make sure that the students know the differences between an *actuator* and a *sensor* and know what a *solenoid* is.

O Show videos *the Automotive Computer: Explaining the Black Box* and *The Automotive Computer: The Computer in Action.* Ask for and answer student questions.

O Assign *Automotive Mechanics GM Computer Command Control* software lessons and quizzes.

- Ↄ Have students read Ken Juran's article, "Electronic Transmission War Stories," from the July 1993 issue of *Motor* magazine.
- O Have students locate electronic control system components on a vehicle.

OBJECTIVE 2 **Describe basic operational stages of a computer control system.**

- O Explain serial data—types of inputs and outputs for various computer systems.
- O Call on students to read aloud Information Sheet material.
- O Have students locate the various sensors and switches on several vehicles of different makes and models.
- O Have students quiz each other on the purposes of the sensors and switches used to send the transmission/transaxle computer information for transmission operation.

OBJECTIVE 3 **Describe the functions of various electrical/electronic test tools.**

- R Review definitions of terms in the "Words You Should Know" box.
- O Show students examples of each tool listed.
- O Call on students to read aloud Information Sheet material.
- O Demonstrate how to use each tool listed.
- O Explain or show variations in manufacturer-specific tools.

OBJECTIVE 4 **State Ohm's Law.**

- R Use Transparency Masters 1-4 to illustrate formulas derived from Ohm's Law.
- R Work some problems on the chalkboard, calling on students for formulas and answers.
- O Call on students to read aloud Information Sheet material.
- O Have students make *pocket references* containing Ohm's Law formulas.

OBJECTIVE 5 **Draw Ohm's Law in wheel expression.**

See Objective 4.

OBJECTIVE 6 **List uses of Ohm's Law.**

See Objective 4.

OBJECTIVE 7 **State the unit of measure formulas from Ohm's Law.**

See Objective 4.

OBJECTIVE 8 **State Ohm's Law for power.**

- R Use Transparency Masters 5-8 to illustrate formulas derived from Ohm's Law for power.
- R Work some problems on the chalkboard, calling on students for formulas and answers.
- O Call on students to read aloud Information Sheet material.
- O Have students make *pocket references* containing formulas from Ohm's Law for power.

OBJECTIVE 9 **Draw Ohm's Law for power in wheel expression.**

See Objective 8.

OBJECTIVE 10 **List uses of Ohm's Law for power.**

See Objective 8.

OBJECTIVE 11 **State the unit of measure formulas from Ohm's Law for power.**

See Objective 8.

OBJECTIVE 12 **Describe the purposes of sensors and switches used to send the electronic control unit information for torque converter clutch operation.**

- R Provide examples and analogies and explain purposes in more detail.

R Show students examples of the various switches and sensors.

O Call on different students to read aloud the purposes of the sensors and switches.

O Call on different students to read aloud the purposes of the sensors and switches.

O Have students locate the various sensors and switches on a rear-wheel drive vehicle.

O Have students quiz each other on the purposes of the sensors and switches used to send the ECU information for torque converter operation.

OBJECTIVE 13 **List advantages of computer control of torque converter.**

R Have students read Information Sheet material.

OBJECTIVE 14 **Explain how a solenoid operates a torque converter clutch.**

O Have students quiz each other on solenoid operation of the TCC.

OBJECTIVE 15 **Solve problems involving Ohm's Law. (Assignment Sheet 1)**

R See the general instructions for all Assignment Sheets.

O Call on a student to read aloud Assignment Sheet introductions and instructions.

OBJECTIVE 16 **Check circuit continuity with an analog ohmmeter. (Job Sheet 1)**

R See the general instructions for all Job Sheets.

R Show students how to use required specialty tools, particularly scanners and diagnostic analyzers.

R Demonstrate how to connect, zero, and read an ohmmeter and digital VOM.

R Review with students the procedures outlined in Unit 8 for reading electric/electronic breakout box diagnostic charts.

R Before assigning the Job Sheet, demonstrate appropriate techniques, suggest stepsavers, and emphasize safety.

R Have students locate circuit diagrams and electronic procedures in the service manual for the make and model vehicle they are servicing.

O Have a student, or students, read aloud the Job Sheet cautions.

OBJECTIVE 17

Measure current, voltage, and resistance with a digital multimeter (VOM). (Job Sheet 2)

See Objective 16.

OBJECTIVE 18

Test transmission/transaxle-related electrical/electronic components. (Job Sheet 3)

See Objective 16.

OBJECTIVE 19

Perform computer relearn procedures. (Job Sheet 4)

See Objective 16.

EVALUATION

Pretest

- Use the unit Written Test for *both* the pretest and posttest. Give the students the pretest before they begin the unit.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving pretests and using the results. Information for ordering this material is included in the optional resources section.
- Use pretest results to guide individual students in progressing through the unit, doing enrichment work, or moving to the next unit.

Focus Assignment

- Use an informal evaluation of the focus assignments as a diagnostic tool for determining if any students need extra help in reading comprehension or writing skills. Refer these students to their English instructor, Learning Resource Center, or Educational Enhancement Center.

Assignment Sheet

- Evaluate students on Assignment Sheet activities. Students must repeat an Assignment Sheet until they have mastered the activity.
- Complete each student's Competency Profile.

Skill Test

- Explain to the students that they will be asked to demonstrate the procedures on the Job Sheets as a skills test.
- Describe the rating scale used on the skills test.
- Reteach and retest as necessary.
- Complete each student's Competency Profile.

Posttest

- After they have completed the unit, give students the Written Test again.
- Explain to the students that they will be asked to demonstrate on the Written Test actions listed in the specific objectives.
- You may wish to use the CIMC publication *Measuring Learning and Competency Gains: The Pretest/Posttest Approach* for instructions and suggestions on giving posttests and using the results. Information for ordering this material is included in the optional resources section.
- Reteach and retest as necessary to meet individual student needs and state standards for student learning and competency gains.
- Complete the appropriate sections of the Competency Profiles.
- Review individual and group performance to evaluate teaching effectiveness. Adjust scope, sequence, or instructional methods for additional lessons as required.

REQUIRED RESOURCES

The items marked with an asterisk are included in the Instructor's Resource Package.

Publications

- Appropriate shop manuals for the vehicle makes and models that will be serviced in job sheet procedures.

OPTIONAL RESOURCES

Publications

- Certification Test Booklet: "Industry and Education, 'Hand in Hand,'" ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.
- Juran, Ken. "Electronic Transmission War Stories," *Motor*. Vol. 180, No. 1, July 1993.

Videos

☑ **NOTE:** All of the following VHS videocassettes are available from Bergwall Productions, Inc., 540 Baltimore Pike, Chadds Ford, PA 19317. Phone 1-800-645-3565.

- *The Digital Ohmmeter/Voltmeter*, 1992
- Scanners Explained (1989 VHS Cassette Series)
  - *Getting Started*, 13 minutes
  - *Troubleshooting*, 13 minutes
- Automotive Electronics Explained (Slides-on-Video Series)
  - *Comparing Old and New Systems*, 13 minutes
  - *Basic Concepts and Equipment*, 14 minutes
  - *Microprocessor Design and Usage*, 12 minutes
  - *Schematics and Components*, 13 minutes
  - *Troubleshooting Techniques*, 13 minutes
- The Automotive Computer (1990 VHS Cassette Series)
  - *Explaining the Black Box*, 15 min
  - *Input—Sensors*, 16 minutes
  - *Output-Actuators*, 14 minutes
  - *The Computer in Action*, 13 minutes

☑ **NOTE:** The following VHS videocassette is available from The American Association for Vocational Instructional Materials, 745 Gaines Road, Athens, GA 30605. Phone 1-800-228-4689.

- *Electric Circuits: Ohm's Law*, 25 minutes

Computer Software

- *Automotive Electronics GM Computer Command Control*, 1989. SHOPWARE Educational Systems, Department KL-4, 101 Hill Road, Aberdeen, WA 98520-7302, (800) 487-3392.

  ☑ **NOTE:** This software contains three lessons and quizzes on three copyable discs.

Other Media

- "Automatic Transmission Repair Worksheets," ATRA, 2472 Eastman Avenue #23, Ventura, CA 93003, (805) 654-1700.

UNIT REFERENCES

Publications

- Bono, Saverio G, and William J. deKryger. *Auto Technology: Theory & Service*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1990.
- Duffy, James E. *Modern Automotive Mechanics*. South Holland, IL: Goodheart-Willcox Company, Inc., 1990.
- Kovacik, Robert T, and Saverio G. Bono. *Automatic Transmissions*. Cincinnati, OH: South-Western Publishing Co., 1984.
- Mitchell International, Inc. *Automatic Transmissions and Transaxles: Fundamentals and Systems*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1989.
- *1991-92 Transmission Service & Repair: Domestic Cars, Light Trucks & Vans*. San Diego, CA: Mitchell International, Inc., 1992.
- Stockel, Martin W. and Martin T. Stockel. *Auto Service and Repair*. South Holland, IL: Goodheart-Willcox Company, Inc., 1991.

ASSIGNMENT SHEETS

OBJECTIVE 15

Assignment Sheet 1

Part 1

1. 12
2. 15
3. 6.25
4. 12
5. 12
6. 17
7. 130
8. 14
9. 12.5
10. 129

Part 2

1. 3
2. 4.3
3. 2.8
4. 4
5. 4.6
6. 150
7. 71.4
8. 38.4
9. 2.7
10. 100

Part 3

1. 3.25
2. 1.45
3. 2.4
4. 2.3
5. 1.6
6. 132
7. 81
8. 220
9. 700
10. 6

Part 4

1. $E = IR$
   $2.5 \times 2.8 = 7$ volts

2. $R = E/I$
   $12/100 = 0.12$ ohms

3. $P = IE$
   $3.5 \times 12 = 42$ watts

4. $I = P/E$
   $100/12 = 8.3$ amps

5. $P = E/I$
   $14 \times 60 = 840$ watts

6. R = E/I
   14/60 = 0.23 ohms

7. I = E/R
   220/10 = 22 amps

8. P = IE
   22 × 220 = 4,840 watts

9. R = E/I
   13/10 = 1.3 ohms

10. P = IE
    1000 x 480 = 480,000 watts

WRITTEN TEST

OBJECTIVE 1

1. I
2. A
3. G
4. H
5. D
6. E
7. F
8. C
9. J
10. B
11. K
12. L

OBJECTIVE 2

Stage 1: input—sensors monitor various operating conditions and send electrical signals (representing these conditions) to the ECU.

Stage 2: processing—computer analyzes the input signals from the sensors and uses this information to decide if adjustment needs to be made in monitored system; also decides how the adjustment will be made.

Stage 3: output—decisions made during processing stage are sent out as electrical signals—representing these decisions—to *actuators*, which make actual physical adjustments in monitored system.

OBJECTIVE 3

1. Jumper wires—used for bypassing a portion of a circuit

2. Test light—used for checking that voltage is present in a circuit; checking for open circuits and short circuits

3. Multimeter (VOM)—used for measuring voltage, current, and resistance

4. Voltmeter—used for measuring the amount of electrical pressure (voltage) in a circuit

5. Ammeter—used for measuring the amount of current (amperes) in a circuit

6. Ohmmeter—used for measuring the amount of resistance (ohms) in a circuit

7. Scan tool—used to retrieve trouble codes; most convert the trouble code directly into a digital display

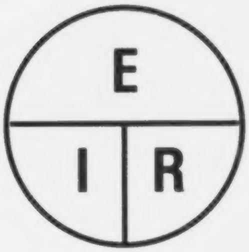
8. Diagnostic analyzer—used to communicate with the ECU and to interpret data from the sensors

9. Breakout box test chart—used as a step-by-step troubleshooting reference for electrical/electronic component testing

OBJECTIVE 4

Ohm's Law—The current in an electric circuit equals the pressure (volts) divided by the resistance.

OBJECTIVE 5



OBJECTIVE 6

1. Calculating circuit *resistance*
2. Calculating circuit *amperage*
3. Calculating circuit *voltage*

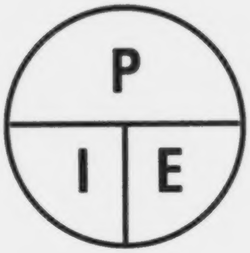
OBJECTIVE 7

1. Formula for voltage—Volts = Amps x Ohms or $E = I \times R$
2. Formula for amperage—Amps = Volts ÷ Ohms or $I = E/R$
3. Formula for resistance—Ohms = Volts ÷ Amps or $R = E/I$

OBJECTIVE 8

Ohm's Law for power—The power in an electrical circuit equals the current (amperes) multiplied by the electromotive force (volts).

OBJECTIVE 9



OBJECTIVE 10

1. Calculating circuit *wattage*
2. Calculating circuit *voltage*
3. Calculating circuit *amperage*

OBJECTIVE 11

1. Formula for wattage—Watts = Amps × Volts or $P = I \times E$
2. Formula for voltage—Volts = Watts ÷ Amps or $E = P/I$
3. Formula for amperage—Amps = Watts ÷ Volts or $I = P/E$

OBJECTIVE 12

1. Control shift quality by controlling shift-valve operation or by directly controlling the flow of oil to the apply device
2. Sends the ECU a voltage signal indicating throttle position
3. Provide ECU with engine load
4. Tells ECU the gear range selected (position of gear selector lever)
5. Sends vehicle-speed signals to ECU in the form of voltage pulses
6. Monitors and measures coolant temperature and relays measurements to the computer

OBJECTIVE 13

Answer should include any five of the following:

- Smooth, crisp, fast, reliable shifts

- Improved fuel economy that meets government regulations
- Automatic shifts made at precisely the right moment
- Smooth response to throttle opening
- Consistent shift quality
- Engine protected by constant scanning of transmission functions
- Ensures proper lockup

OBJECTIVE 14

1. The TCC solenoid is located in the valve body or in the front pump, depending on the automatic transmission.
2. The TCC provides a direct 1:1 mechanical coupling between the engine and the transmission.
3. Electrical and electronic torque-converter clutch controls are used only with hydraulically applied converter clutches.
4. The application of the clutch piston is regulated by an electric solenoid and one or more spool valves.
5. The solenoid controls the pressure that signals the spool valves when to lock and unlock the TCC assembly.
6. The spool valves control the various pressures that actually apply and release the clutch piston.
7. In some applications, when the solenoid *is not* energized, oil pressure in the converter clutch-apply circuit passes through the solenoid check valve and is vented to the transmission sump.
8. In some applications, when the solenoid *is* energized, the check ball in the solenoid check valve seats to close off the exhaust passage, and oil pressure is directed to the spool valves that apply the TCC.

OBJECTIVE 15

Evaluated on Assignment Sheet 1.

OBJECTIVES 16-19

Evaluated on Job Sheets 1-4.

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) Automatic Transmission/Transaxle Specialist

UNIT NUMBER AND TITLE – 9 – Testing Related Electronic Components

TOTAL NUMBER OF TEST QUESTIONS 59

TOTAL NUMBER OF BASIC SKILL QUESTIONS 28

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-12	X
2	1-3	W
3	1-9	W
4	1	X
5	1	W
6	1-3	X
7	1-3	X
8	1	X
9	1	W
10	1-3	X
11	1-3	X
12	1-6	W
13	1-5	X
14	1-8	W
15	Evaluated on AS 1	
16-19	Evaluated on JS 1-4	

Automatic Transmission/ Transaxle Specialist

Instructional Supplement

Reading

Science

Creative Thinking/ Problem Solving

Writing

Oral Communication

Employability

Math

Interpersonal or Relating

Social Studies

Reading Comprehension

- If students have difficulty gaining factual information:
    - ☐ Remind students that they probably read for many reasons. One of these reasons is to learn new information. The reason you have for reading helps determine the way you read.
    - ☐ Have students discuss the different techniques they use when reading. Lead the discussion so that students realize that, when they read for fun, they may read quickly; they may skim some parts and read others more carefully. Reading for facts requires more care.
    - ☐ Suggest that one technique found to be successful includes the following steps:
        - ▸ Identify in advance what it is you want to learn. Be certain that before starting to read, you have a clear understanding of what you want to accomplish. It sometimes helps to list the questions to be answered.
        - ▸ If the material to be read includes a table of contents, study it to get an understanding of how the material is organized.
        - ▸ Scan through the material noting headings, highlighted information, illustrations, etc.
        - ▸ Read the material carefully. Take notes or highlight as you read, listing or marking the information you want to learn. Note key words and ideas.
        - ▸ Study your notes/highlighted material. Ask yourself if you found all you wanted to learn. If not, read the material again or locate another source for the information.
    - ☐ Tell students that they should find a personal technique for reading to learn factual information.
- If students have difficulty drawing conclusions:
    - ☐ Remind students that when they analyze a situation, perform a job task, or even discuss a television show or movie, they will often be asked to demonstrate understanding by telling what happened and explaining why it happened.
    - ☐ Provide opportunities for students to practice drawing conclusions by describing events, such as a group of people crowded around a table that has a decorated cake with lighted candles on it, and asking them to decide what is happening. Have them explain why they reached that conclusion.

- ☐ Provide opportunities for students to practice drawing conclusions. Present students with descriptions of events, or with photographs or drawings, and ask them to describe what is happening. Ask the student(s) to support each response.
- ☐ Remind students that before they can draw conclusions, they must carefully observe what is happening and think about why it is happening. In more complex situations, it is often a good idea to take notes about possible conclusions as you work.

Research and Reference

- If students have difficulty selecting useful resources:
    - ☐ Review the different types of resources available to students. Have volunteers tell what kind of information can be found in each resource type. Have them discuss the types of projects on which each resource can assist.
    - ☐ Help students learn how to locate each resource in libraries, resource centers, or media centers.
- If students have difficulty locating resources:
    - ☐ Review the different types of resources available to students. Have volunteers tell what kind of information can be found in each resource type. Have them discuss the types of projects on which each resource can assist.
    - ☐ Have students volunteer to tell how they would locate the resources discussed. (Be sure they know how to locate each resource in libraries, resource centers, or media centers.) Discuss the use of the library's card catalog or its computerized location system.
- If students have difficulty using standard references:
    - ☐ Review the purpose(s) of the specific reference work. Give examples of situations and the reference appropriate for each.
    - ☐ Illustrate the proper use of each reference work. Have students practice using each reference in a task-specific situation.
- If students have difficulty using in-book reference tools:
    - ☐ Identify the in-book reference tools in a specific reference work: table of contents, index, glossary, appendices, tabs, color codes, list of figures, list of tables, list of symbols, maps, "how to use this book" pages, and others.
    - ☐ Illustrate the proper use of each in-book reference tool. Have students practice using each tool in a task-specific situation.

Functional Reading

- If students have difficulty following written instructions:
  - ☐ Discuss the possible consequences of not following instructions precisely.
  - ☐ Review the *importance* of following written instructions. Give appropriate scenarios when written instructions are not followed or are not followed completely and correctly.
  - ☐ Discuss the *relationship* between the order of written instructions and the appropriate outcome. Emphasize the need to follow written instructions in their proper order. Use examples where the order of instructions in a sequence is critical to the outcome of the task.
  - ☐ Explain to students that one of the keys to following written directions successfully is to read the directions completely before actually beginning to follow them. Doing this ensures that you will not be surprised as you work through the steps. It also gives you an opportunity to ask questions about steps you do not understand.
  - ☐ Tell students that, after they have read the directions and understand what to do, they should go back to Step 1 and follow the directions step-by-step (without skipping any steps). Remind students that it is important to follow steps in order, even if they think they already know what to do.
- If students have difficulty interpreting graphics and symbols:
  - ☐ Remind students that interpreting a graphic is very similar to reading a page. Each part of the graphic or symbol has a meaning within the art.
  - ☐ Suggest that, when they have a graphic, chart, diagram, or table to interpret, they should carefully study the art and compare it to any similar pieces encountered. They should also study the key or any other information that will help in understanding the graphic.
  - ☐ Review the symbols being used. Discuss the purposes for each symbol. Discuss the importance of memorizing the symbols.
  - ☐ Discuss sample graphics and the purposes for each. Create or locate other examples of graphics and ask students to interpret them.
  - ☐ Explain the importance of correctly interpreting graphics and symbols. Describe possible consequences of incorrect interpretations.
- If students have difficulty using content area vocabulary:
  - ☐ Remind students that nearly every occupation or group uses words that have specific, specialized meanings to others in the same occupation or group. Have them name and define some content area, technical, or "slang" words with which they are familiar.

- Explain that using content area or technical words makes it easier for people within groups or occupations to communicate ideas accurately. Remind students that often the same word may have a generic meaning to the majority of people, but a very specific meaning within an industry.
- Review key terms and concepts, so that students hear, see, write, and say them.
- Have students suggest ways to learn the meanings of the vocabulary specific to what they are studying. Provide opportunities for students to practice using the terminology they will need.

- If students have difficulty interpreting abbreviations/acronyms:
    - Present examples of appropriate abbreviations and/or acronyms. Use actual examples from specific sources, such as newspapers, books, and others.
    - Ask students to interpret the examples. Give hints, if needed.

Operation and Calculation

- If students have difficulty calculating with whole numbers:
    - Review basic skills in addition, subtraction, multiplication, and division.
    - Review mathematical terminology. (For example, "compare" indicates that you must subtract.)
    - Suggest the use of a calculator to check answers.
- If students have difficulty calculating with decimals:
    - Show how the decimal system is based on groups of ten.
    - Demonstrate how our money system is a decimal system.
    - Review addition, subtraction, multiplication, and division skills using decimals. Demonstrate sample calculations.
- If students have difficulty solving formulae and equations:
    - Review the components of each formula or equation, including abbreviations and terminology.
    - Review any special notation, such as exponential notation.

  - Review the operation(s) involved such as addition, subtraction, multiplication, and division. Solve sample formulae or equations, then ask the student to solve other samples. Guide the student's work as needed.
  - Refer the student to the appropriate section(s) of textbooks and other resources, if needed.

- If students have difficulty converting units of measure:
  - Define the units the students will be working with. For instance, write on the board that one cup equals eight ounces or one inch equals 2.54 centimeters.
  - Define equivalents in fractional form. Eight ounces in a cup can be written as 8oz/cup or cup/8 oz. Set up a diagonal relationship so the student can cross cancel and determine the desired unit.

Math Application

- If students have difficulty solving word problems:
  - Discuss the approach to solving word problems. Instruct students to read the information carefully, noting the key elements of the problem.
  - Solve a sample word problem similar to the problems to be solved by students.
- If students have difficulty selecting and applying mathematical formulas:
  - Review basic math formulas and math skills with the class or with individual students as necessary.
  - Remind students that basic math skills are used daily in such ways as counting change and paying for purchases. Remind them that they use basic mathematical formulas, such as addition and subtraction, to figure their wages and to balance their checkbooks.

Functional Math

- If students have difficulty making measurements:
  - Remind students that a key to making accurate measurements is to understand the techniques used for the type of measurement being made.
  - Suggest that students ask questions such as: How should the measurement be recorded (nearest inch)? What should be used to make the measurement? Are there special instructions that should be followed? Understanding what is expected and what must be learned makes the measuring task easier.

  - Review what is to be measured, the tools to be used, and any special instructions to be followed. Allow students time to practice using and reading the tool or measuring device.
  - Review the units of measure in the English and metric systems, if appropriate.
  - Demonstrate the correct procedure for making the required measurement(s).

General Science

- If students have difficulty using scientific instruments:
  - Discuss, demonstrate, and review the procedures. Provide more opportunities for students to practice using the instrument.

Cognitive Activities

- If students have difficulty analyzing/synthesizing information:
  - Define the terms "analyze" and "synthesize." Compare and contrast their meanings.
  - Remind them that to analyze they must break the information down into all its component parts in order to understand it.
  - Remind them that to synthesize information they should put all the component parts together in a way that makes the information usable.
  - Explain that it is usually necessary to learn about complex items or things by examining their make-up or parts, such as studying body structure by examining each individual system or studying auto mechanics by examining the different automobile systems.
  - Also explain that it is sometimes necessary to then study the whole item or thing by studying how the parts work together to make the whole item work. This examination helps us identify and compare the relationships the parts have with each other.

- ☐ Help the students understand the concepts by asking what they would do if they turned on a light and nothing happened. Lead them to discuss that they would probably first check to see if the light was plugged in or if the bulb was burned out. Plugging it in or replacing the light bulb might make the light come back on.

- ☐ Then ask the students what they would do if the light still didn't work. Lead them to the conclusion that they should check to see if all the electricity was off. If it is, they will have to think about what they know about the whole electrical system—what are its parts. Identifying the parts of the whole will help them identify the problem.

- If students have difficulty drawing conclusions:

  - ☐ Remind students that when they conduct an experiment, perform a job task, or discuss a subject, they will often be asked to draw conclusions. Give examples of such situations.

  - ☐ Explain that, before conclusions can be drawn, students must first observe carefully what is happening and why it may be happening. Suggest that, with complex experiments, a good set of notes taken while conducting the experiment can help in drawing conclusions.

  - ☐ Have students practice drawing conclusions. When possible, choose situations appropriate for the occupation or subject (such as an actual experiment, etc.). Or, use a general situation using photographs or a videotape without the volume. Ask students to state what is happening in each picture (their conclusion). Have students support their conclusions.

- If students have difficulty transferring knowledge/training to new situations:

  - ☐ Remind the students that everything they do makes use of information that they already know. Tell them that this process of using known information often happens subconsciously. When you identify an animal as a dog, you use already known information—you know what dogs look and act like so you can recognize a dog.

  - ☐ Tell the students that when they encounter a situation or a question they aren't familiar with, they should examine it carefully to identify what they already know that will help them solve the problem or answer the question. For practice, use examples such as the following:

  - ☐ A baby you are caring for starts crying. You don't know why, but you do want to make her stop. How do you know what to try? Begin by thinking carefully about what you know about why babies cry. (hungry, diaper needs changing, wants attention, sick) Identifying what you already know gives you ideas to try that might make the baby stop crying.

- ☐ Remind the students that when trying to solve a problem or answer a question, they should always identify what they know by thinking about similar situations, problems, or questions they have faced. This will help them with find the answer.

Job Acquisition/Development

- If students have difficulty mastering specific job task/procedure:
  - ☐ Discuss the importance of mastering specific job tasks or procedures. Explain that it is probably impossible to find a job where there isn't a task or procedure to be mastered. Remind them that future employers will be more likely to hire people who can already perform the tasks required.
  - ☐ Ask the students to share methods they have used to master specific job tasks or procedures. Discuss these methods with the class.
  - ☐ Emphasize the fact that practice makes a person proficient and proficiency makes a person confident.
  - ☐ Suggest they study each component of the procedure to determine which area is causing difficulty.
  - ☐ Review the entire procedure.
  - ☐ Team them with proficient students or professionals to practice the procedure.
- If students have difficulty practicing good work habits/attitudes:
  - ☐ Remind the students that future employers are looking for people with good work habits. Have the students list what they think are good work habits. Discuss each suggestion as it is named. Have them identify ways to improve work habits.
  - ☐ Distinguish between habits and attitudes. Demonstrate how it is possible to have good work habits, but a poor attitude.
  - ☐ Explain the role of good work habits and attitudes in obtaining and retaining employment.
  - ☐ Distinguish between good and poor work habits and attitudes. Give examples.
  - ☐ Discuss the employer's expectations of the student on the job.

Automatic Transmission/ Transaxle Specialist

Instructor's Resource Package

LAP Sheets

Transparency Masters

Written Tests

Developed by the
Curriculum and Instructional Materials Center
for the Division of Trade and Industrial Education
Oklahoma Department of Vocational and Technical Education

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Printed in the United States of America by the
Oklahoma Department of Vocational and Technical Education
Stillwater, Oklahoma 74074-4364

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LAP
SHEET

INTRODUCTION TO AUTOMATIC TRANSMISSIONS AND TRANSAXLES

1

Check the blank as you complete each step.

1. **Take** ___ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.
2. **Read** ___ the Introduction, Unit Objective, and Specific Objectives.
3. **Do** ___ the Focus Assignments.
4. **Stop** ___ and have your instructor evaluate your work from the Focus Assignment. After your work has been evaluated, follow your instructor's recommendations.
5. **Study** ___ the Information Sheet, Objectives 1 and 2.
6. **Do** ___ the Assignment Sheet. Study the example problems. If necessary, ask your instructor to work additional problems before you complete the Assignment Sheet.
7. **Stop** ___ and have your instructor evaluate your work from the Assignment Sheet. After your work has been evaluated, follow your instructor's recommendations.
8. **Study** ___ the Information Sheet, Objectives 3 and 4. Ask your instructor to show you an example of a stator, impeller, and turbine.
9. **Study** ___ the Information Sheet, Objective 5.
10. **Ask** ___ your instructor to relate the basic transmission/transaxle components to the basic components common to simple hydraulic systems.
11. **Ask** ___ your instructor to show you an actual transmission and transaxle, compare and contrast them, and point out and explain for you the components of each.

Optional:
Identify ___ for your instructor the components discussed in this unit on an actual transmission and transaxle.

12. Study ___ the Information Sheet, Objective 6.

Optional: Ask ___ your instructor to show you examples of each of the transmission/transaxle types.

13. Study ___ the Information Sheet, Objectives 7-8.

Optional: Ask ___ your instructor to show you examples of each of the symptoms.

14. Study ___ the Information Sheet, Objective 9.

Optional: Ask ___ your instructor to describe for you examples of technicians who were stumped or who found themselves without the correct replacement part, because they failed to identify the transmission before servicing.

15. Study ___ the Information Sheet, Objective 10.

Optional: Make ___ flashcards showing the various pan-gasket shapes, then quiz yourself on the make and model transmission to which the different shapes belong.

Optional: Ask ___ your instructor to provide you with different serial numbers and service manuals. Match the serial numbers to the correct make and model transmissions.

16. Study ___ the Information Sheet, Objective 11.

Optional: Ask ___ your instructor to show you examples of typical ATF, aftermarket "racing" ATF, and Ford CJ ATF. Have your instructor demonstrate the color change that occurs when water contaminates transmission fluid.

Optional: Ask ___ your instructor for a sample of transmission fluid from an overheated or abused transmission; smell the fluid.

17. Study ___ the Information Sheet, Objectives 12-13.

18. **Write** ___ your responses to the following questions: Why do you think too little and too much transmission fluid lead to aeration? Why do aerated ATF and too little ATF lower hydraulic pressure? Why do aerated ATF and too much ATF lead to overheating? Give your responses to your instructor and ask your instructor to review them with you.

Optional: Ask ___ your instructor for examples of aerated ATF, oil-pan screens containing varnish buildup, and examples of oxidation.

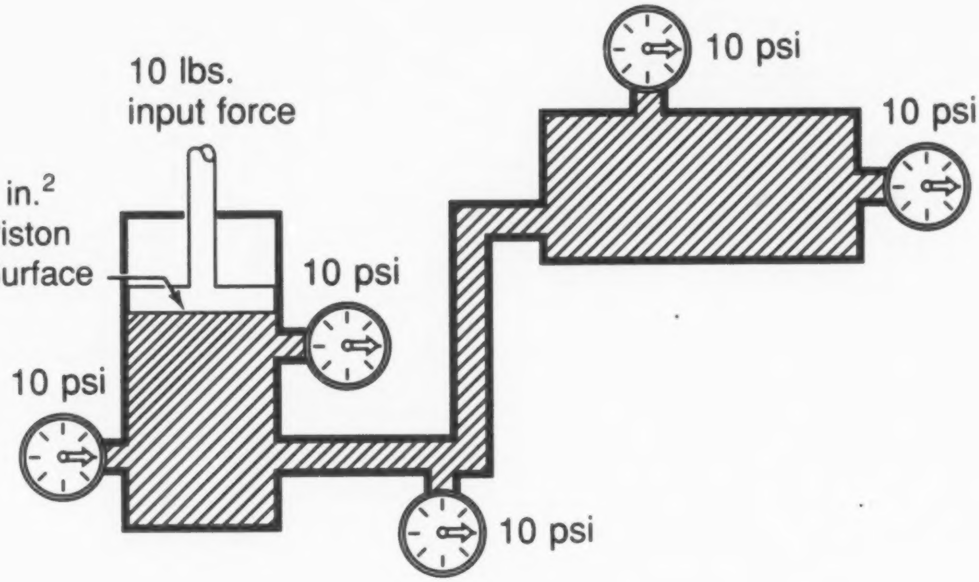
19. **Study** ___ the Information Sheet, Objectives 14-15.

Optional: Ask ___ your instructor to show you examples of drums, bands, servos, accumulator pistons, and multiple-disc and overrunning clutches on a vehicle.

20. **Take** ___ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

Hydraulic Theory—Pascal's Law

- Liquids cannot be compressed.
- Liquids transmit pressure equally in all directions.



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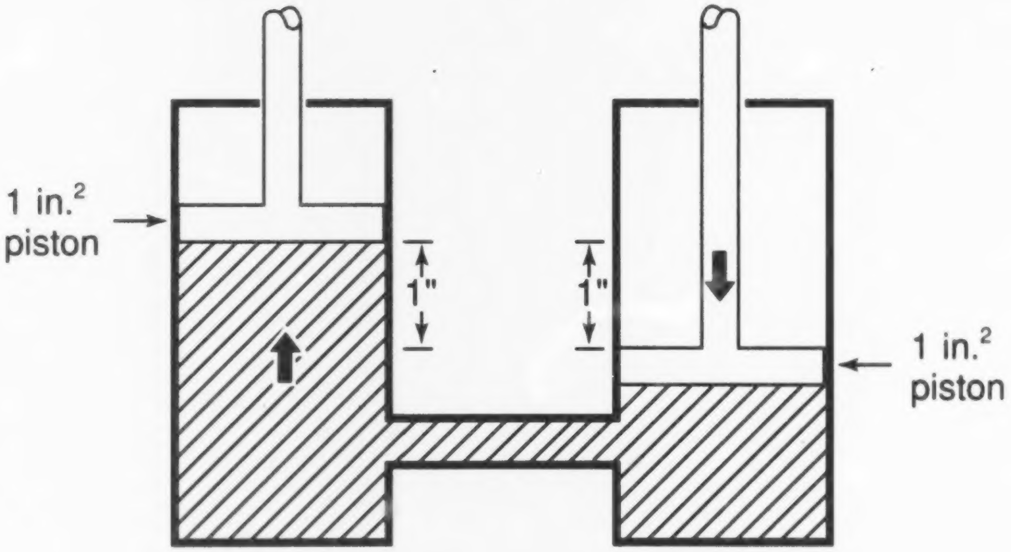
Hydraulic Theory— Motion

- Motion and force can be transmitted without change from one cylinder to another through tubing.



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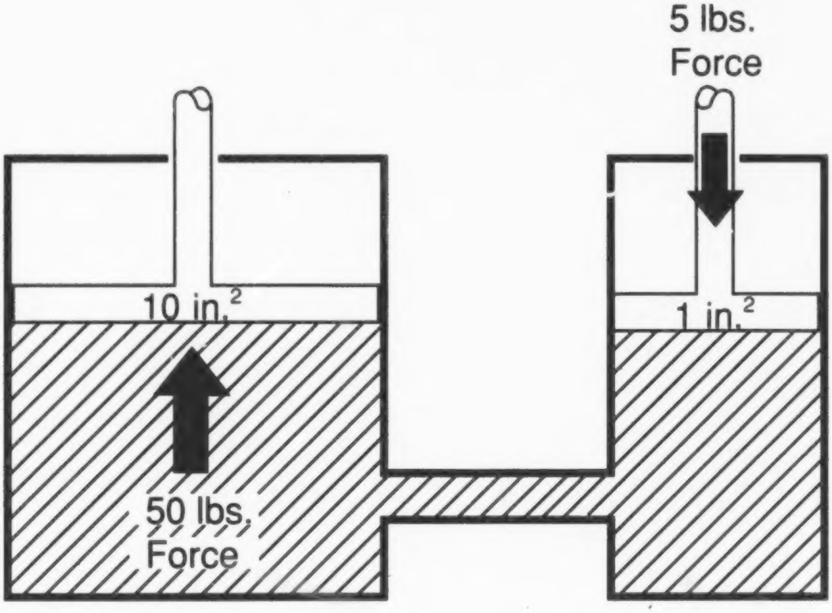
Hydraulic Theory— Surface Area

- Motion and force can be multiplied by using pistons with different surface areas.



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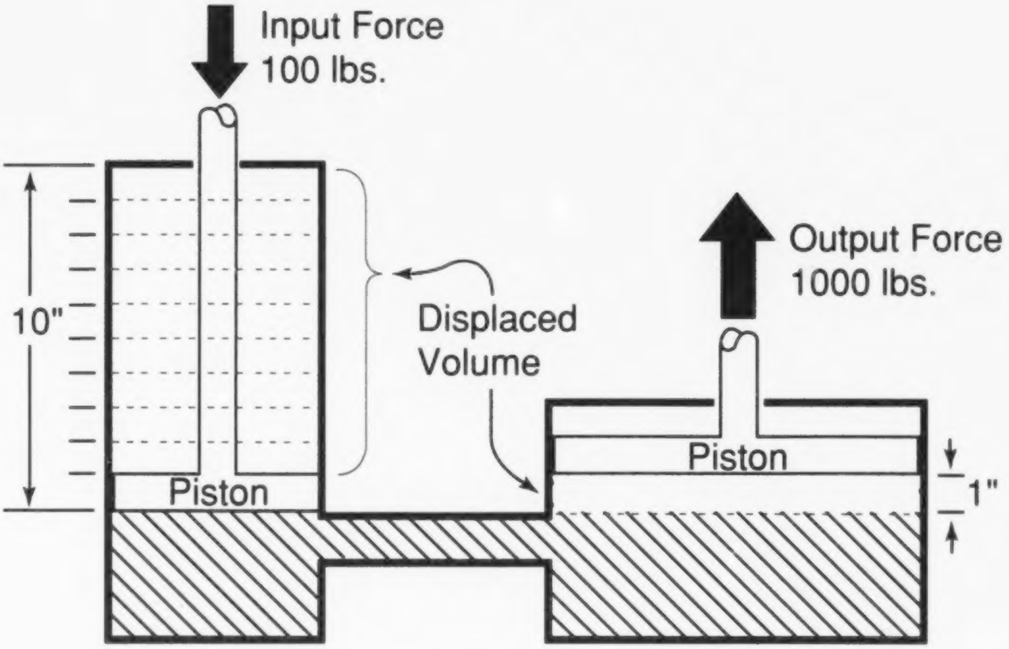
Hydraulic Theory— Surface Area

- Fluid volume needed to stroke a piston is determined by piston diameter and stroke length.



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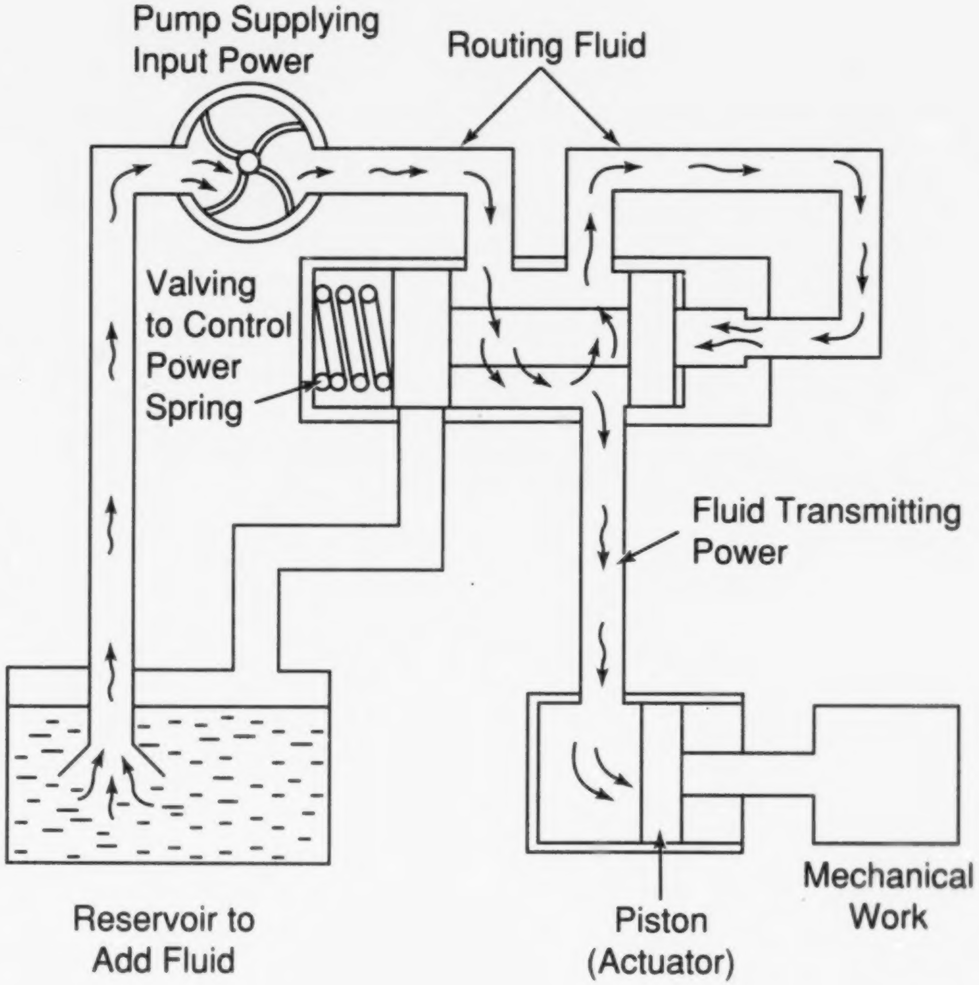
Basic Components of a Simple Hydraulic System



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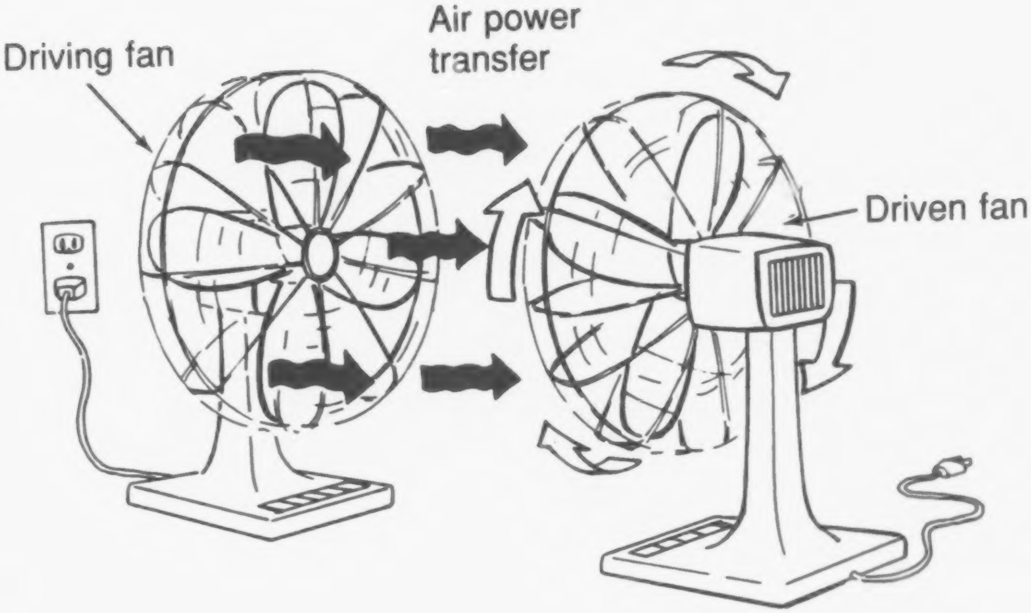
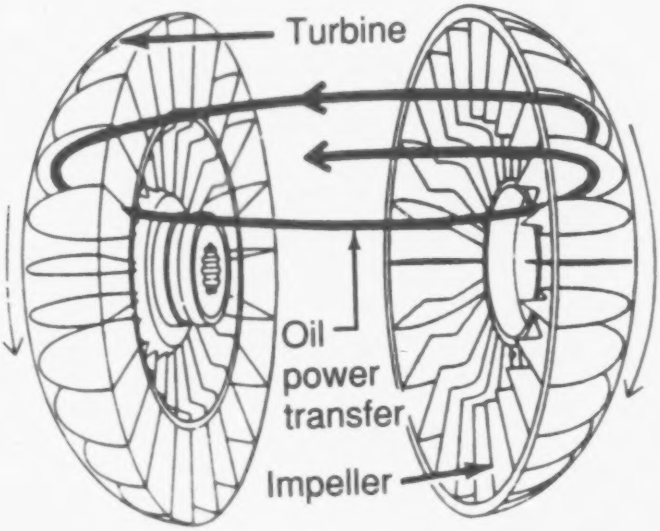
Power Transfer





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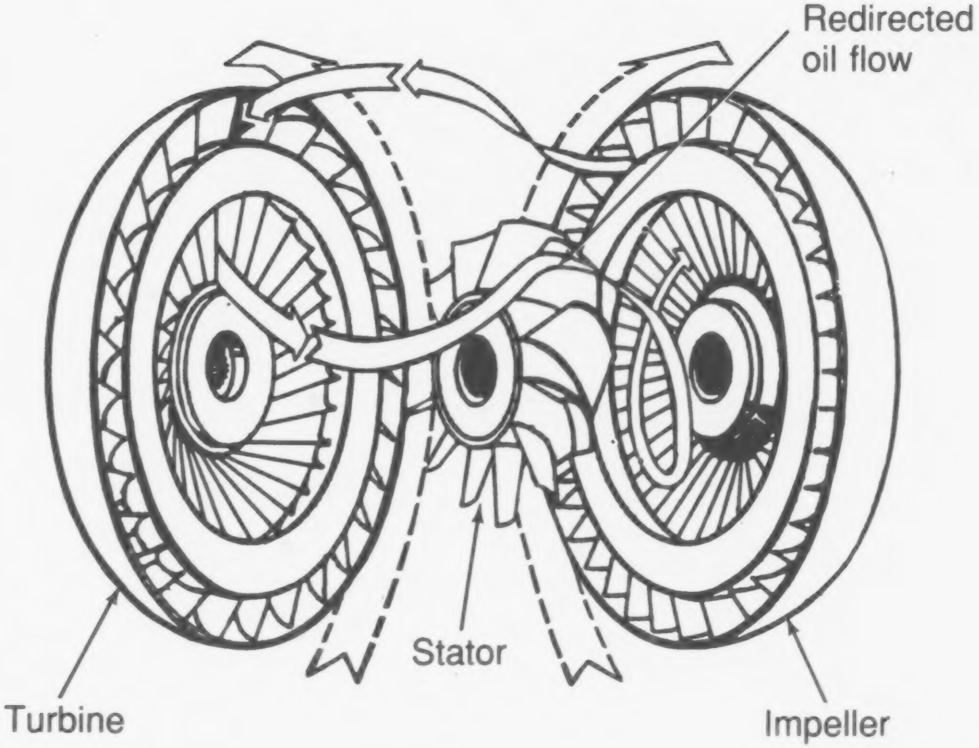
Torque Multiplication



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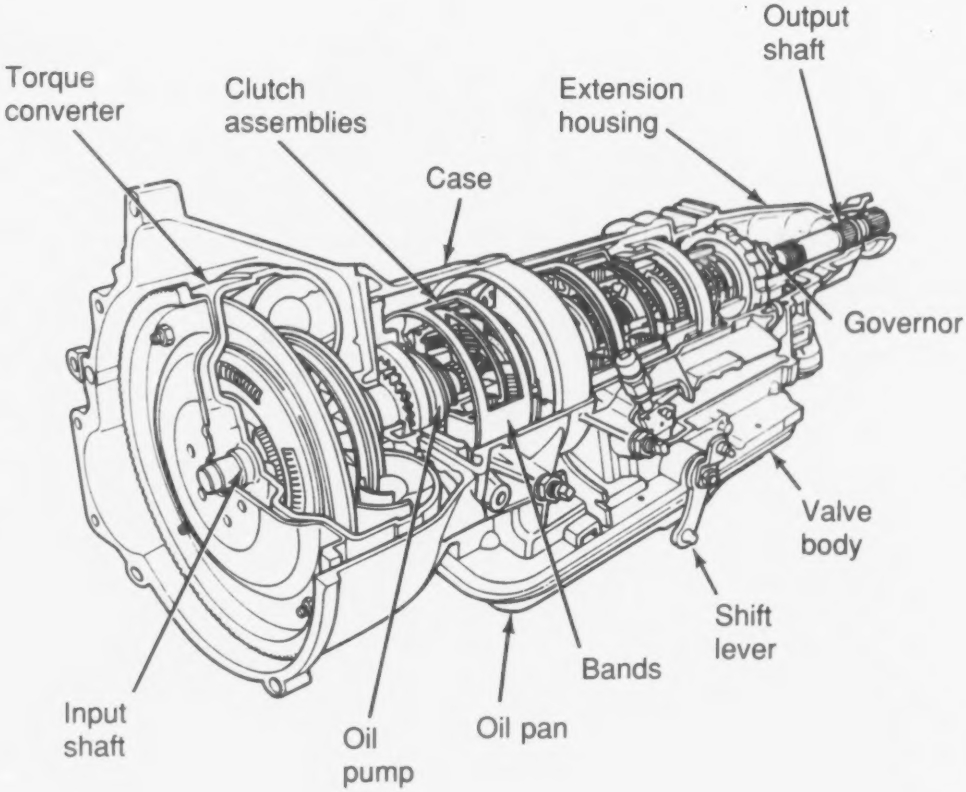
Components of an Automatic Transmission



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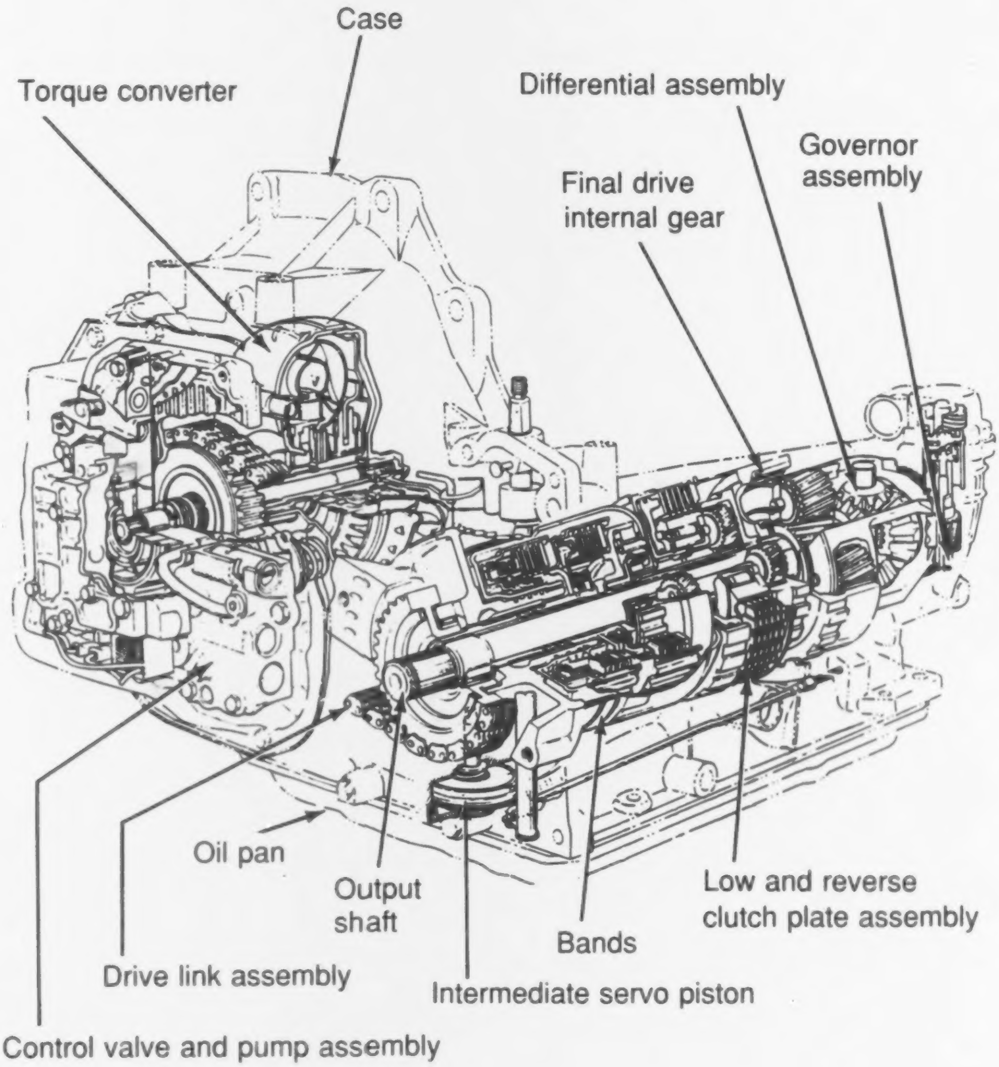
Basic Components of an Automatic Transaxle


Case
Torque converter
Differential assembly
Governor assembly
Final drive internal gear
Oil pan
Output shaft
Low and reverse clutch plate assembly
Bands
Drive link assembly
Intermediate servo piston
Control valve and pump assembly

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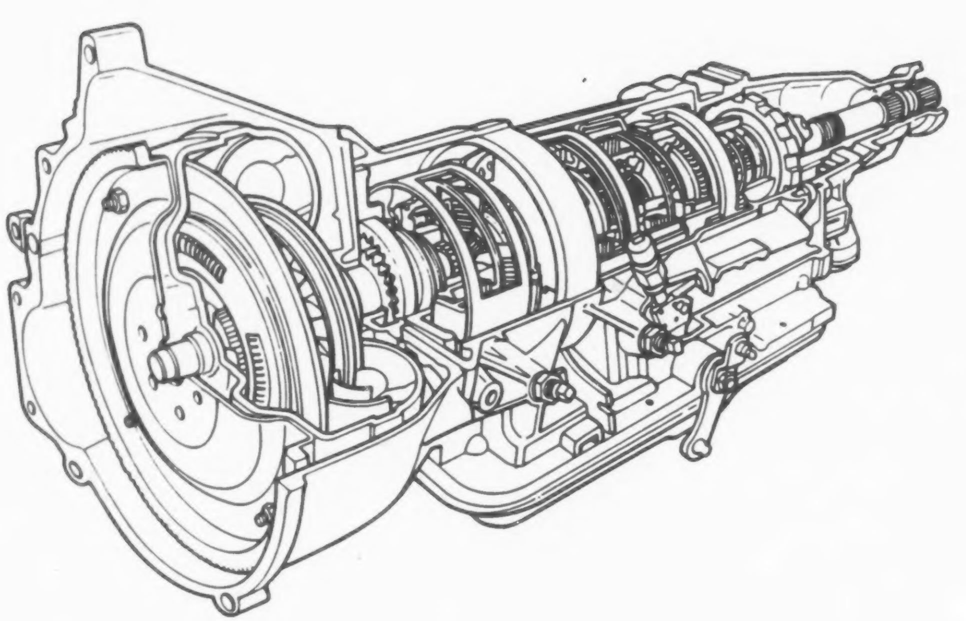
Stepped-Ratio Transmission (Modern Four-Speed)



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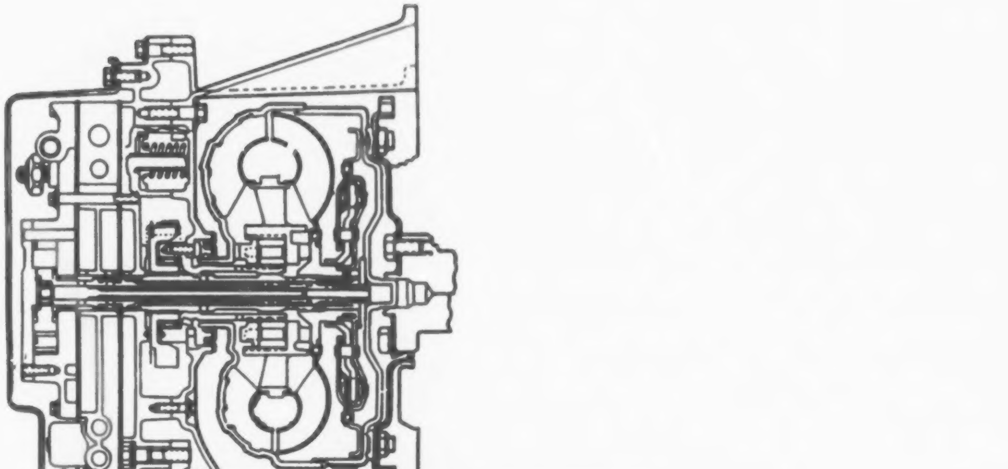
Stepped-Ratio Transaxle (Modern Overdrive)



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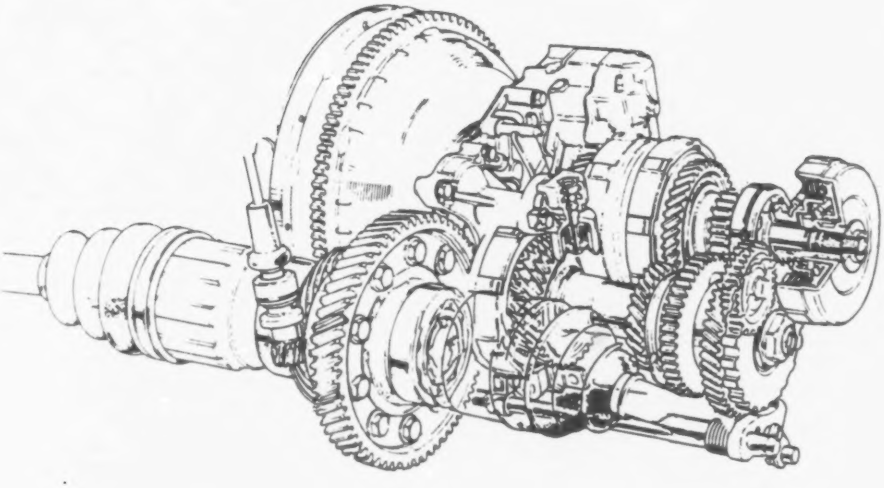
Nonplanetary Gear Transmission (Hondamatic®)



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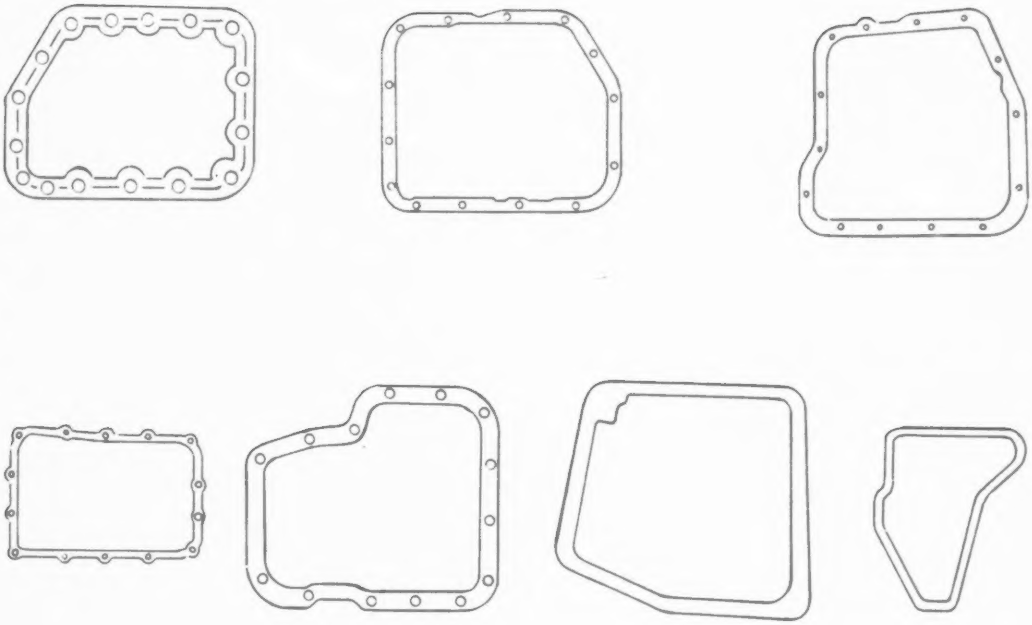
Sample Automatic Transmission Pan-Gasket Shapes



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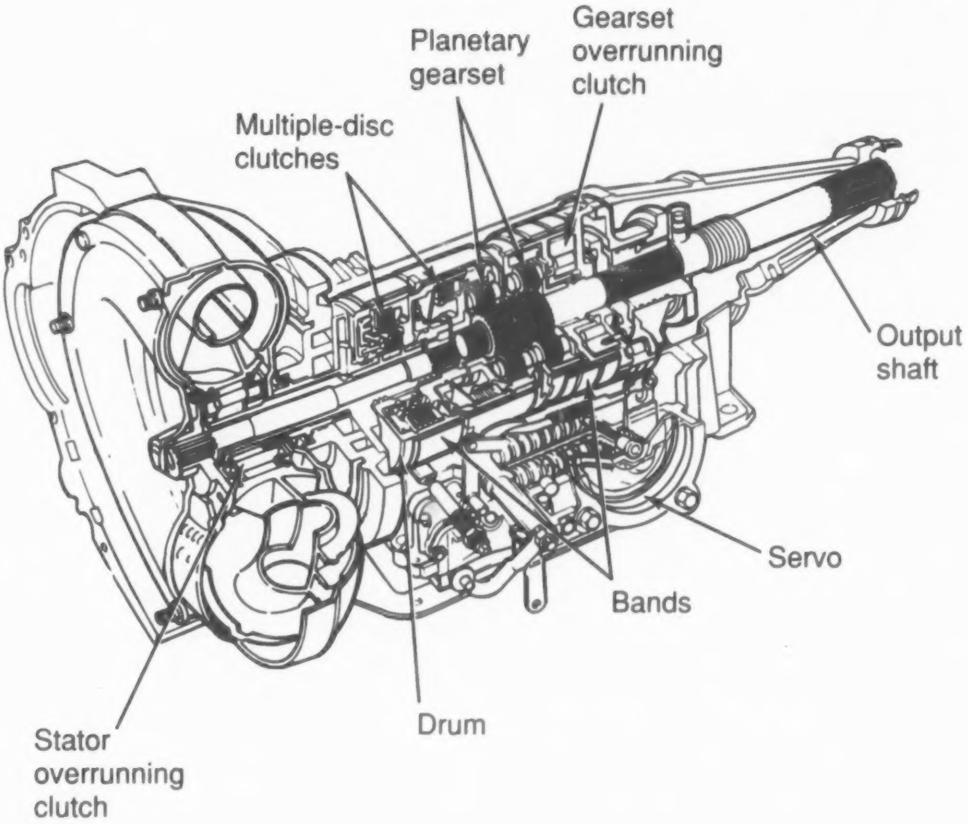
Automatic Transmission Friction Devices



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WRITTEN TEST

INTRODUCTION TO AUTOMATIC TRANSMISSIONS AND TRANSAXLES

1

Name ________________________________ Score __________

OBJECTIVE 1

Correct false statements about hydraulic theory. Write an "X" before each *incorrect* statement. Correct each incorrect statement on the blanks provided below it.

____ 1. Liquids cannot be expanded.

____

____

____ 2. Liquids take the shape of whatever container they are in.

____

____

____ 3. Newton's Law states that liquids transmit pressure equally in all directions; therefore, hydraulic pressure acts with equal force on all surfaces.

____

____

____ 4. Applied force is inversely related to the results obtained.

____

____

____ 5. Once a container is full of liquid, any added force becomes fluid pressure.

____

____

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____ 6. A hydraulic system creates and transmits energy.

____

____

____ 7. Motion and force can be transmitted—with a minimal 20 percent change—from one cylinder to another through tubing.

____

____

____ 8. It is not possible to change motion to force or vice versa.

____

____

____ 9. When force is increased, motion is decreased; when force is decreased, motion is increased.

____

____

____ 10. Pistons of two different surface areas increase force.

____

____

____ 11. The volume of fluid required to stroke a piston is determined by the length and diameter of the piston.

____

____

OBJECTIVE 2 **Evaluated on the Assignment Sheet.**

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OBJECTIVE 3

Explain the functions of basic components common to simple hydraulic systems.

1. engine- or motor-driven pump — ____________________

2. fluid — ____________________

3. reservoir — ____________________

4. filter — ____________________

5. tubes or cylinders — ____________________

6. valves — ____________________

7. actuators — ____________________

OBJECTIVE 4

Explain how a torque converter functions as both a fluid coupling and a torque multiplier.

Fluid coupling

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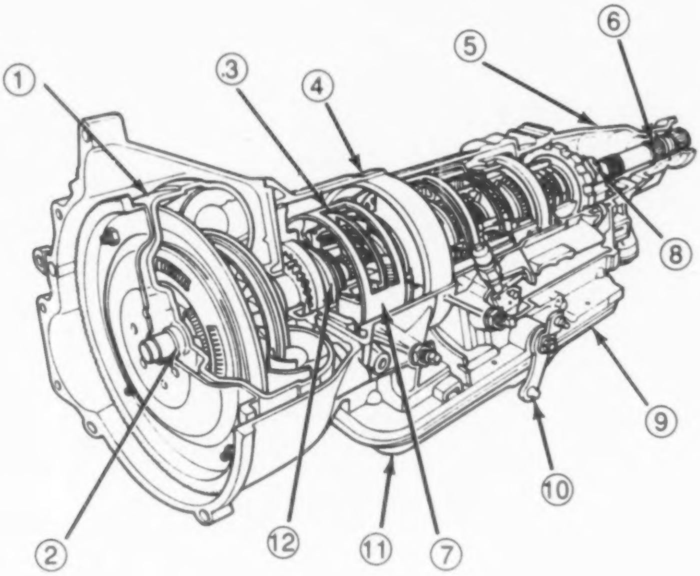
Torque multiplier

May be photocopied for student use.

OBJECTIVE 5

Label the basic components of an automatic transmission and an automatic transaxle. Write the correct component names in the blanks provided below each of the following illustrations.

Automatic transmission



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1. ______________________
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11. ______________________
12. ______________________

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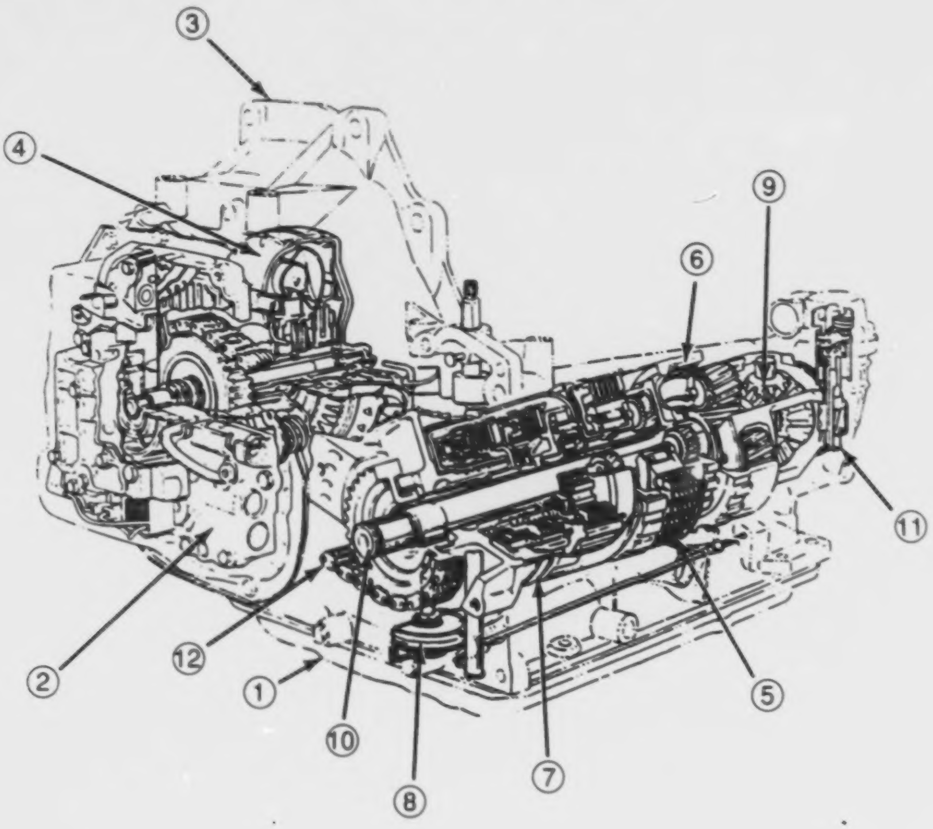
Automatic transaxle



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1. ____________________

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11. ____________________

12. ____________________

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OBJECTIVE 6

List types of automatic transmissions/transaxles.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

OBJECTIVE 7

List the advantages and disadvantages of conventional automatic transmissions/transaxles over manual transmissions. List three advantages and three disadvantages.

Advantages

1. ______________________________

2. ______________________________

3. ______________________________

Disadvantages

1. ______________________________

2. ______________________________

3. ______________________________

OBJECTIVE 8

Distinguish between symptoms that require simple service and those that require overhaul or repair. Write an "X" in the blanks before those that require simple service.

_____ 1. Heavy varnish buildup

_____ 2. Oxidized fluid

_____ 3. Extreme burn odor

_____ 4. Burned fluid

_____ 5. Plugged filters

_____ 6. High mileage without previous service

_____ 7. Presence of water/coolant

_____ 8. Routine mileage interval

_____ 9. Clogged filters

May be photocopied for student use.

OBJECTIVE 9 **State reasons for identifying a transmission before servicing.**

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

OBJECTIVE 10 **State ways of identifying an automatic transmission before servicing.**

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

OBJECTIVE 11 **Answer questions about automatic transmission fluid.**

1. What color is most ATF dyed?

____

2. What color are aftermarket racing fluids?

____

3. What color is Ford CJ transmission fluid?

____

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4. What is indicated by any change in normal ATF color?

5. What does a pinkish or milky ATF color indicate?

6. What type of odor does ATF normally have?

7. What is indicated when ATF smells like burned popcorn or rotten eggs?

OBJECTIVE 12 **State the functions of automatic transmission fluid.**

1. ______

2. ______

3. ______

4. ______

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OBJECTIVE 13 **List the effects of too little or too much automatic transmission fluid.**

Effect of too little ATF

____

____

Effects of too much ATF

____

____

OBJECTIVE 14 **Explain the functions of given friction devices.**

1. drum ____________________________________
2. band ____________________________________
3. servo ____________________________________
4. accumulator piston __________________________
5. multiple-disc clutch _________________________
6. overrunning clutch __________________________

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OBJECTIVE 15

Match automatic transmission gear indicators/gears with their functions. Write the letter (**A** through **F**) of the answer in each blank.

A. park gear (P)
B. reverse gear (R)
C. neutral gear (N)
D. drive (high) gears (D)
E. intermediate gears (I)
F. low gears (L)

____ 1. Allow vehicle speed to increase while engine speed decreases; provide automatic shifts from low to high gear and from high to low gear as necessary

____ 2. Locks the drive wheels to prevent vehicle movement

____ 3. Multiply the engine's torque so that there will be enough power to move the vehicle; provide engine braking if needed

____ 4. Allows the vehicle to move backwards

____ 5. Prevent high-gear operation

____ 6. Allows the engine to run without moving the vehicle

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LAP SHEET

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Check the blank as you complete each step.

1. **Take**	___	the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.
2. **Read**	___	the introduction, unit objective, and specific objectives.
3. **Do**	___	the focus assignments.
4. **Stop**	___	and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.
5. **Study**	___	the Information Sheet, Objective 1. Ask your instructor to show you examples of each component on a bench model transmission. Ask your instructor about variations in component placement and design on various vehicle makes and models.
6. **Study**	___	the Information Sheet, Objective 2. Ask your instructor to provide examples and analogies, and to explain functions in greater detail.
7. **Ask**	___	your instructor to show you examples of bushings, gaskets, seals, and filters.
8. **Study**	___	the Information Sheet, Objective 3.
Optional: Ask	___	your instructor to show you examples of throttle linkage components.
Optional: Locate	___	the throttle linkage on a rear-wheel drive vehicle.
9. **Study**	___	the Information Sheet, Objective 4.
10. **Study**	___	the Information Sheet, Objective 5. Ask your instructor to provide examples and analogies to describe the problems caused by a defective vacuum modulator in greater detail.

11. **Study**	___	the Information Sheet, Objective 6. Ask your instructor to explain how the vacuum modulator and governor work together to determine shift points.
12. **Study**	___	the Information Sheet, Objective 7. Ask your instructor to show you examples of governor components.
Optional: Locate	___	the governor on a rear-wheel drive vehicle.
13. **Study**	___	the Information Sheet, Objective 8. Identify on a bench model each of the possible leak sources.
14. **Study**	___	the Information Sheet, Objective 9.
Optional: Ask	___	your instructor to demonstrate each of the leak detection methods.
15. **Study**	___	the Information Sheet, Objective 10.
Optional: Identify	___	on an actual valve body each of the components shown.
16. **Study**	___	the Information Sheet, Objective 11.
Optional: Ask	___	your instructor to show you examples of each type of valve.
17. **Study**	___	the Information Sheet, Objective 12.
Optional: Ask	___	your instructor to show you an example of a spool valve and to point out its lands, faces, and valleys.
Optional: Ask	___	your instructor to show you examples of each of the valves.
Optional: Ask	___	your instructor to point out each of the different valves as they are arranged in the valve body. Inspect the spool valves in the valve body to see the precision and closeness of their fit.
18. **Study**	___	the Information Sheet, Objective 13.
Optional: Ask	___	your instructor to show you an example of an actual servo assembly.

19. **Study** ___ the Information Sheet, Objective 14. Ask your instructor to show you examples of each of the terms on actual servo linkages.

Optional:
Ask ___ your instructor to show you examples of the various servo operating linkages.

20. **Study** ___ the Information Sheet, Objective 15.

Optional:
Ask ___ your instructor to show you an accumulator or an exploded view of an accumulator in a shop manual.

21. **Learn** ___ how to use any required specialty tools.

22. **Locate** ___ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

23. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

24. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

25. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

26. **Locate** ___ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

27. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

28. **Ask** ___ your instructor to show you how to locate the extension housing bushing and seal (including microsleeve) on various vehicle makes and models.

29. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

30. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

31. **Locate** ___ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

32. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

33. **Ask** ___ your instructor to show you how to locate the manual shift valve and throttle valve linkages and cables on a RWD vehicle.

34. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

35. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

36. **Locate** ___ the procedure(s) for Job Sheet 4 in the service manual for the make and model vehicle you are servicing.

37. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 4. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

38. **Ask** ___ your instructor to show you how to locate the vacuum modulator, lines, and hoses on both FWD and RWD vehicles.

39. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

40. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

41. **Locate** ___ the procedure(s) for Job Sheet 5 in the service manual for the make and model vehicle you are servicing.

42. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 5. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

43. **Ask** ___ your instructor to show you how to locate the governor assembly on various makes and models of vehicles.

44. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

45. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

46. **Locate** ___ the procedure(s) for Job Sheet 6 in the service manual for the make and model vehicle you are servicing.

47. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 6. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

48. **Ask** ___ your instructor to show you how to locate the valve body on various makes and models of vehicles.

49. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

50. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

51. **Locate** ___ the procedure(s) for Job Sheet 7 in the service manual for the make and model vehicle you are servicing.

52. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 7. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

53. **Ask** ___ your instructor to show you how to locate the servo assembly on various makes and models of vehicles.

54. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

55. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

56. **Locate** ___ the procedure(s) for Job Sheet 8 in the service manual for the make and model vehicle you are servicing.

57. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 8. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

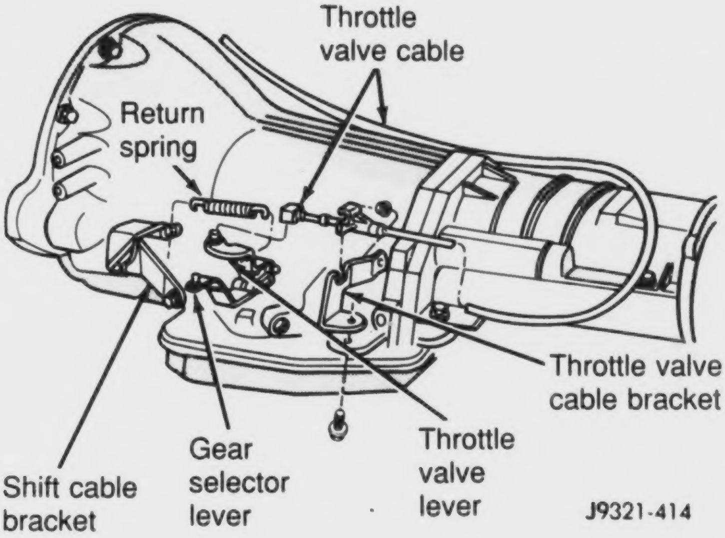
58. **Ask** ___ your instructor to show you how to locate the accumulator on various makes and models of vehicles.

59. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

60. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

61. **Take** ___ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

Typical Throttle Linkage



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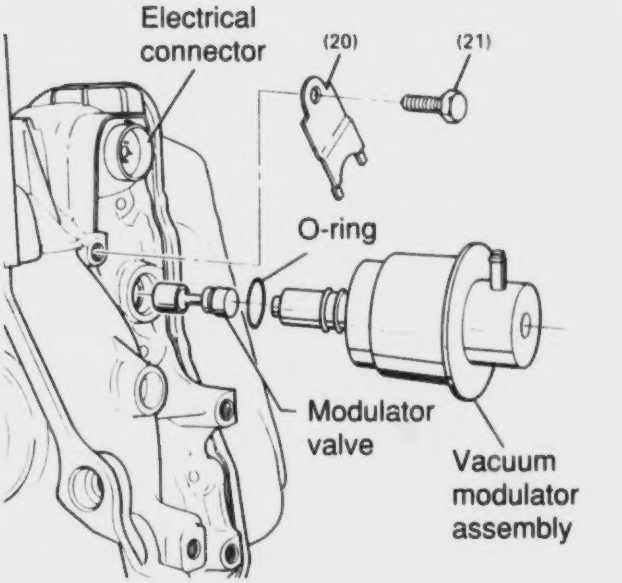
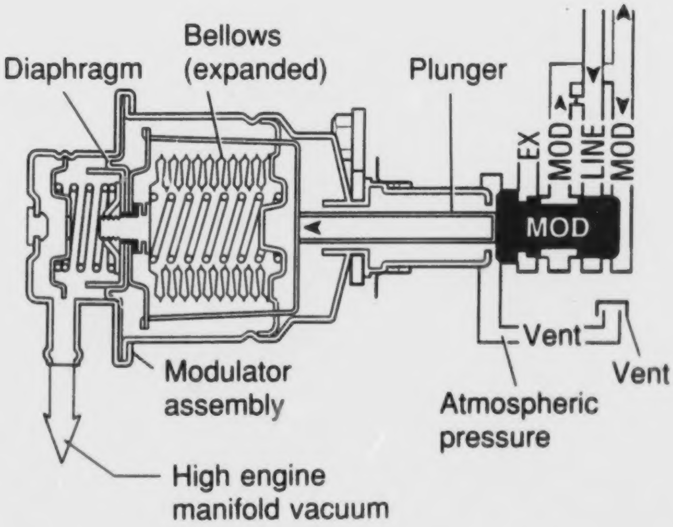
Dual-Area Vacuum Control Diaphragm Unit





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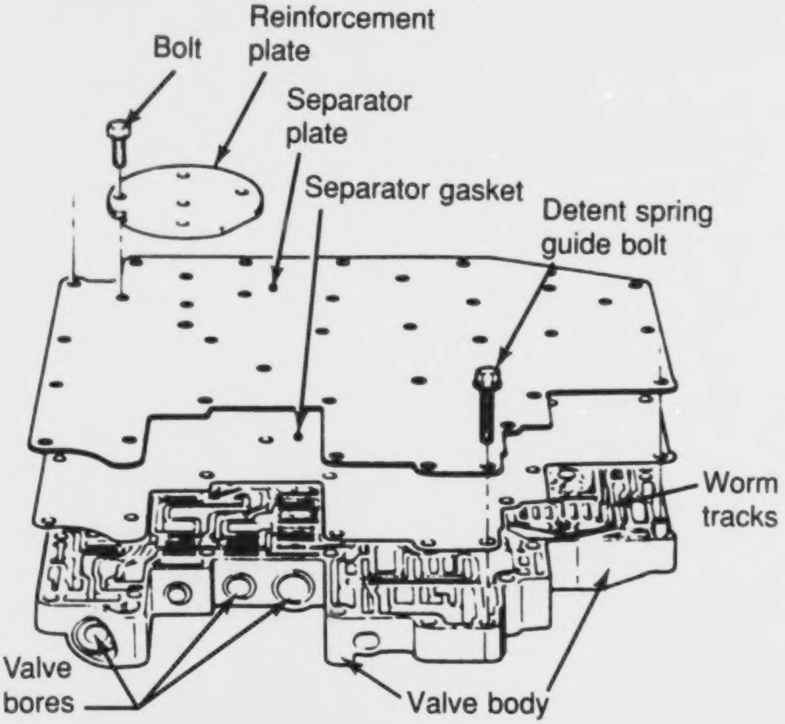
Basic Parts of a Valve-Body Assembly



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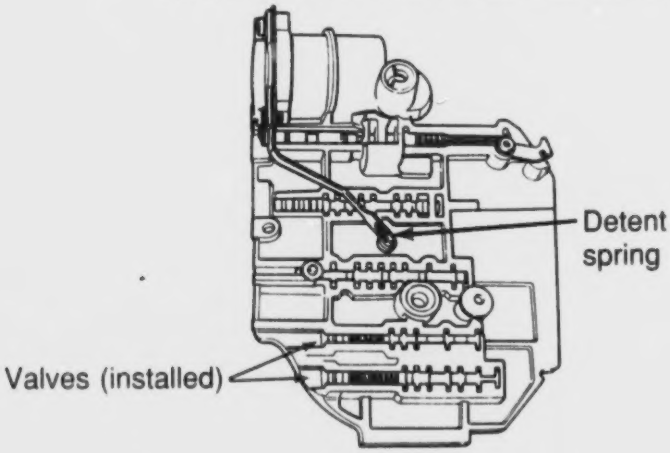

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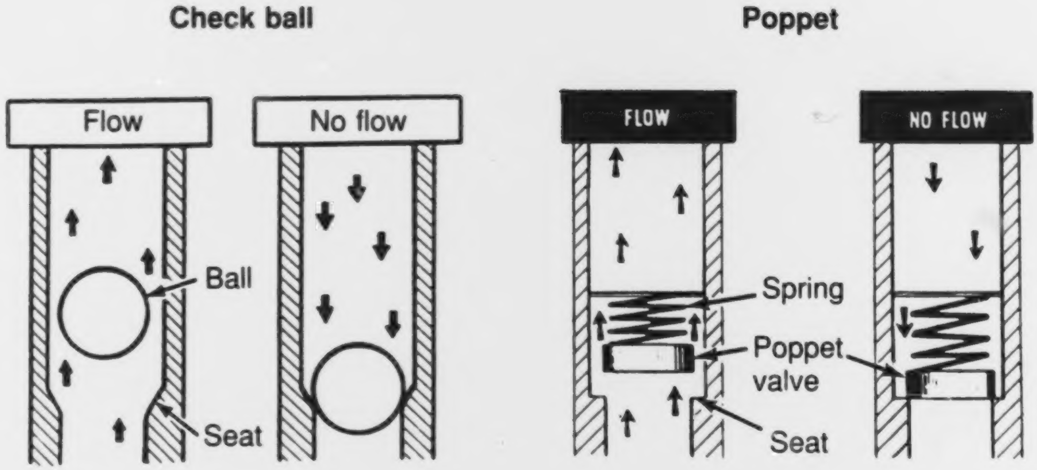
Types of Valves Used in Valve Bodies



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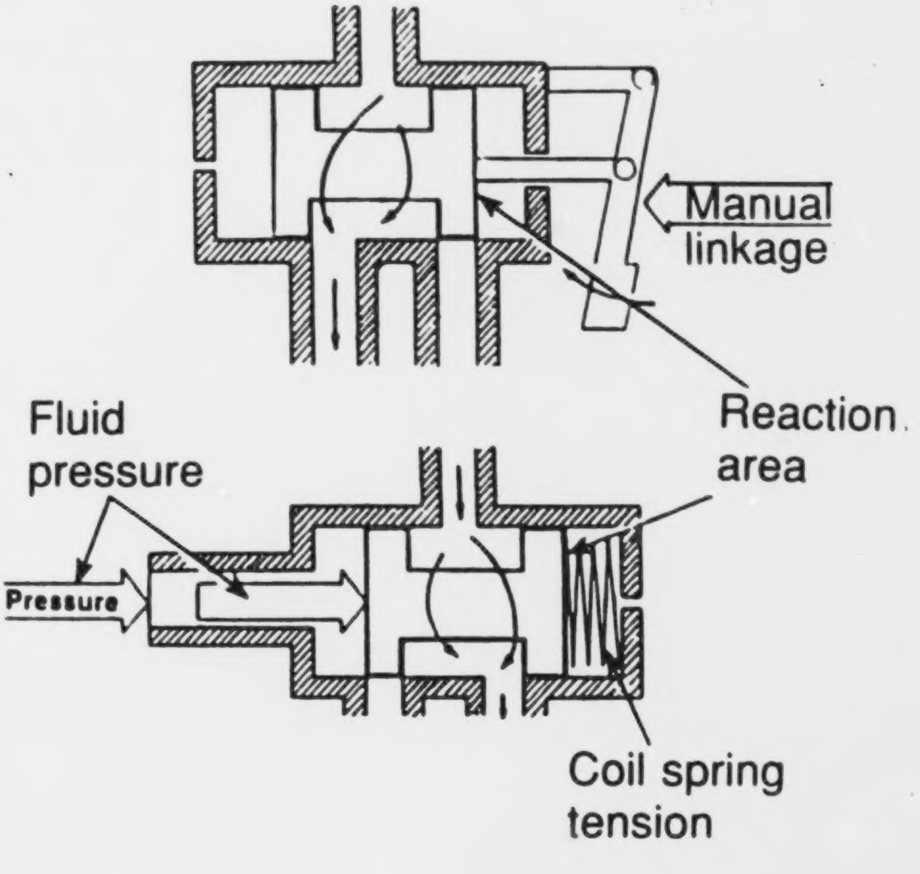
Types of Valves Used in Valve Bodies

Balance



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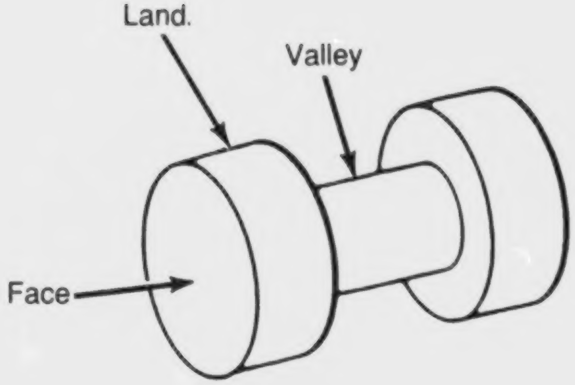
Spool Valve Configuration



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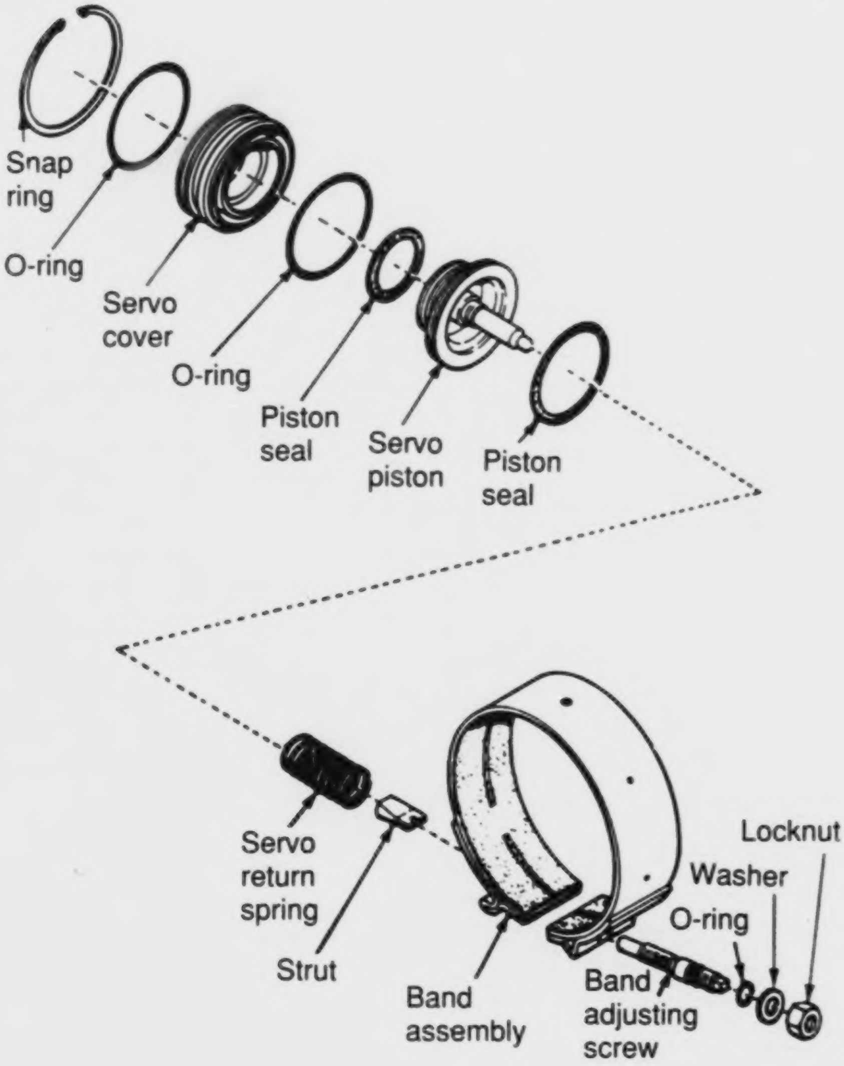
Typical Servo Assembly



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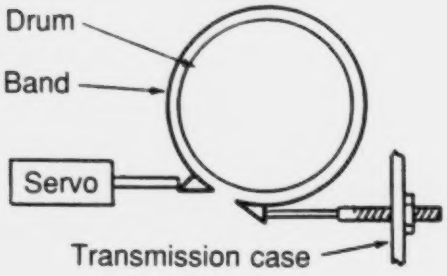
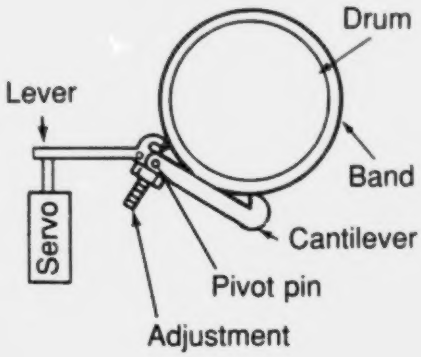
Servo Operating Linkages

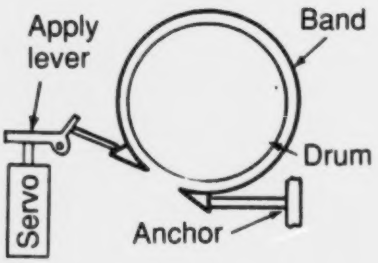
Straight linkage



Cantilever linkage



Lever linkage



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WRITTEN TEST

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Name ______________________ Score __________

OBJECTIVE 1

Label basic hydraulic-related components of a modern four-speed automatic transmission/transaxle. Your instructor will dipslay basic hydraulic-related components and will number each. Write the correct names after the corresponding numbers.

1. ______________ 6. ______________

2. ______________ 7. ______________

3. ______________ 8. ______________

4. ______________ 9. ______________

5. ______________ 10. ______________

OBJECTIVE 2

Describe the functions of basic hydraulic-related automatic transmission components. Write a short description of each component's function.

1. automatic transmission ______________________

____

2. accumulator ______________________

____

3. bushing ______________________

____

4. case ______________________

____

5. extension housing assembly ______________________

____

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6. gasket ______________________________

____

7. oil-pan filter ______________________________

____

8. oil seal ______________________________

____

9. piston ______________________________

____

10. pump ______________________________

____

11. servo ______________________________

____

12. valve ______________________________

____

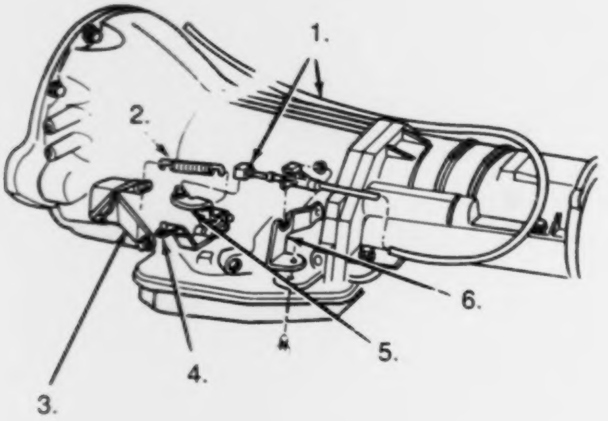
13. valve body ______________________________

____

May be photocopied for student use.

OBJECTIVE 3

Label the parts of the typical throttle linkage on a rear-wheel drive transmission. Write the names in the blanks provided below the illustration.



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1. ______________________

2. ______________________

3. ______________________

4. ______________________

5. ______________________

6. ______________________

OBJECTIVE 4

State the purpose of a vacuum modulator.

____

____

OBJECTIVE 5

List problems caused by a defective vacuum modulator. List four (4) problems.

1. ____

2. ____

3. ____

4. ____

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OBJECTIVE 6 **State the purpose of the transmission governor.**

____

____

OBJECTIVE 7 **Label the parts of a typical governor assembly.** Your instructor will display the parts of a typical governor assembly and will number each. Write the correct names after the corresponding numbers.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

OBJECTIVE 8 **List possible sources of transmission fluid leaks.** List ten (10) of the possible sources in the blanks provided.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

OBJECTIVE 9 **Describe common methods of identifying leaks.**

1. Inspecting visually ______________________________

   ____

2. Cleaning and inspecting visually ____________________

   ____

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3. Using compressed air ______________________________

____

4. Using vacuum tester ______________________________

____

5. Using leak-detecting additive ______________________________

____

6. Using leak-detecting powder ______________________________

____

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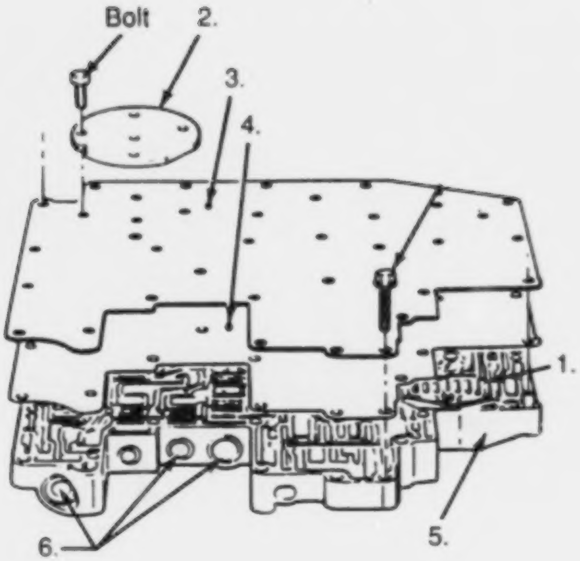
OBJECTIVE 10 **Label the basic parts of a valve-body assembly.** Write the correct names in the blanks provided below the illustrations.



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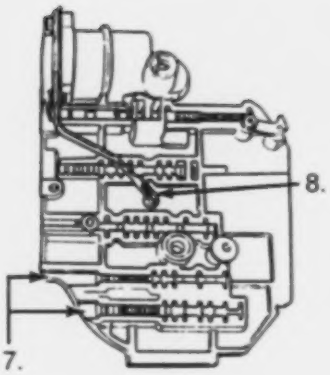

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1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

8. ____________________

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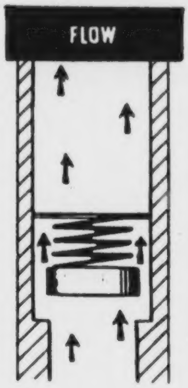
OBJECTIVE 11

Identify types of valves used in automatic transmission valve bodies. Write the correct name in the blank provided below each illustration.



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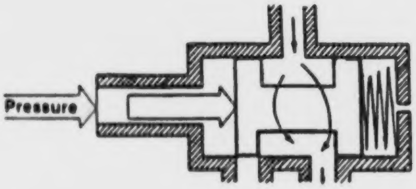
1. ______________________



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2. ______________________

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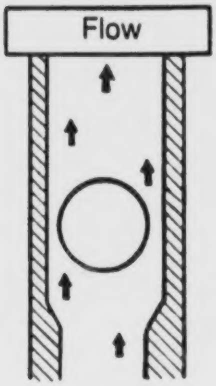

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3. ____________________

OBJECTIVE 12

Match types of valve-body valves with their characteristics. Write the letters in the blanks provided.

A. check-ball valve
B. poppet valve
C. spool valve
D. balance valve

_____ 1. Type of hydraulic control valve that slides back and forth in machined bores as hydraulic pressure is applied to the faces of its various lands

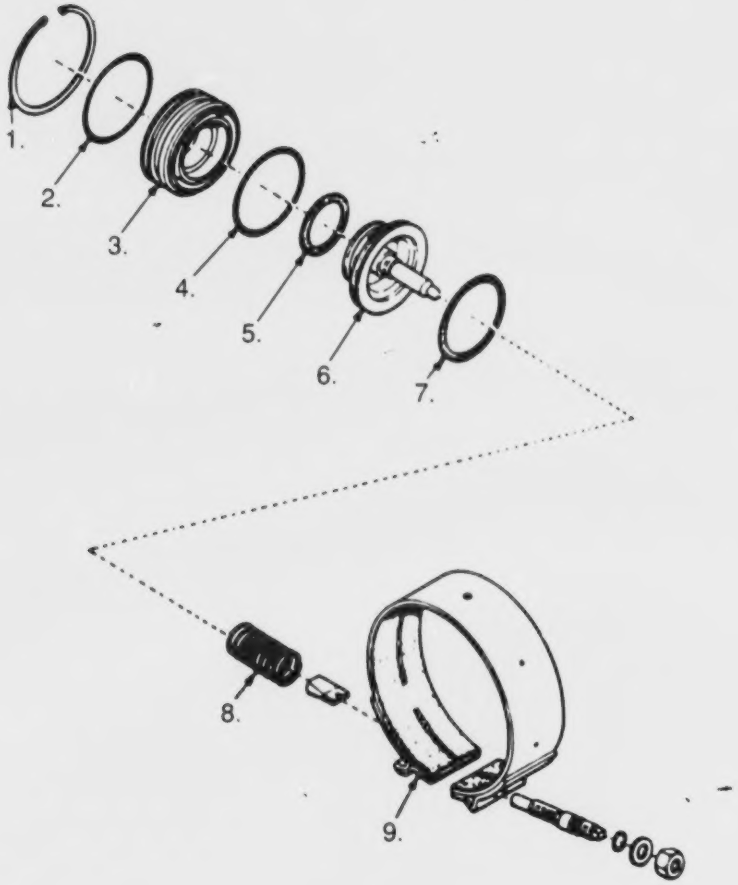
_____ 2. Type of one- or two-way check valve in which fluid pressure or manually operated linkage forces ball against passage to stop fluid flow; pressure on other side unseats the ball

_____ 3. Spool valve and spring combination used to regulate hydraulic-system pressure; some also use auxiliary lever force

_____ 4. Type of one-way check valve in which fluid passes through the valve only after hydraulic pressure exceeds the spring pressure holding a flat disc or a ball against its seat

May be photocopied for student use.

OBJECTIVE 13 **Label the basic parts of a typical servo assembly.** Write the names in the blanks provided below the illustration.



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1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

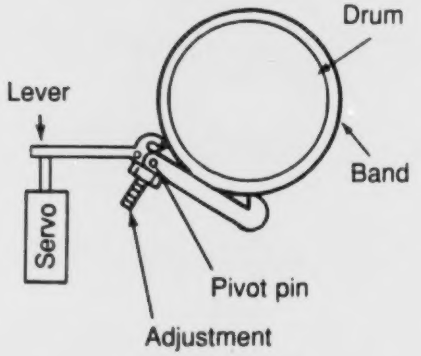
7. ____________________

8. ____________________

9. ____________________

OBJECTIVE 14

Identify types of servo operating linkages. Write the name in the blank provided below each of the following illustrations.



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1. ____________________

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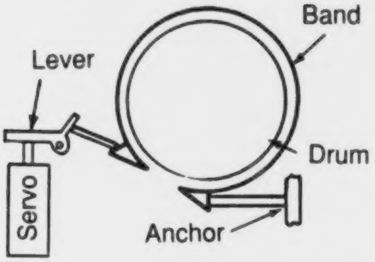

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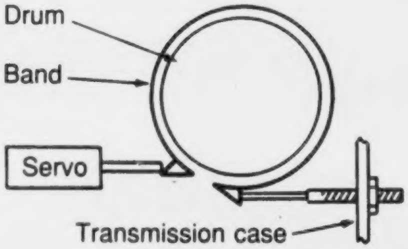
2. ____________________



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3. ____________________

OBJECTIVE 15

State the purposes of the accumulator.

1. ____

____

2. ____

____

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OBJECTIVES 16-23

Evaluated on Job Sheets 1-8.

224

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LAP SHEET

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

3

Check the blank as you complete each step.

1. **Take** ___ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

2. **Read** ___ the Introduction, Unit Objective, and Specific Objectives.

3. **Do** ___ the Focus Assignments.

4. **Stop** ___ and have your instructor evaluate your work from the Focus Assignment. After your work has been evaluated, follow your instructor's recommendations.

5. **Study** ___ the Information Sheet, Objectives 1 and 2.

Optional: Ask ___ your instructor for examples of console shift linkage components.

Optional: Locate ___ the console shift linkage on a rear-wheel drive vehicle.

6. **Study** ___ the Information Sheet, Objective 3.

Optional: Ask ___ your instructor for examples of column shift linkage components.

Optional: Locate ___ the column shift linkage on a rear-wheel drive vehicle.

7. **Study** ___ the Information Sheet, Objective 4. Ask your instructor for examples and analogies which will help explain the functions.

8. **Ask** ___ your instructor for examples of the various switches and linkages.

Optional: Locate ___ the various linkages and controls on a rear-wheel drive vehicle.

9. **Study** ___ the Information Sheet, Objective 5. Ask your instructor for examples and analogies which will help explain the indicators.

10. **Study** ___ the Information Sheet, Objective 6. Ask your instructor to explain the importance of seal fit.

11. **Watch** ___ your instructor demonstrate how to check round and square-cut seals for fit. Demonstrate the procedure for your instructor.

12. **Watch** ___ your instructor demonstrate how to check lip-type seals for fit. Demonstrate the procedure for your instructor.

13. **Watch** ___ your instructor demonstrate how to check hook-type and butt-type metal sealing rings for fit. Demonstrate the procedure for your instructor.

14. **Watch** ___ your instructor demonstrate how to check solid and scarf-cut Teflon® sealing rings for fit. Demonstrate the procedure for your instructor.

15. **Study** ___ the Information Sheet, Objective 7. Study the locations of the bushings, thrust bearings, and thrust washers illustrated.

16. **Study** ___ the Information Sheet, Objectives 8 and 9.

17. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

18. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

19. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

20. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

21. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

22. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

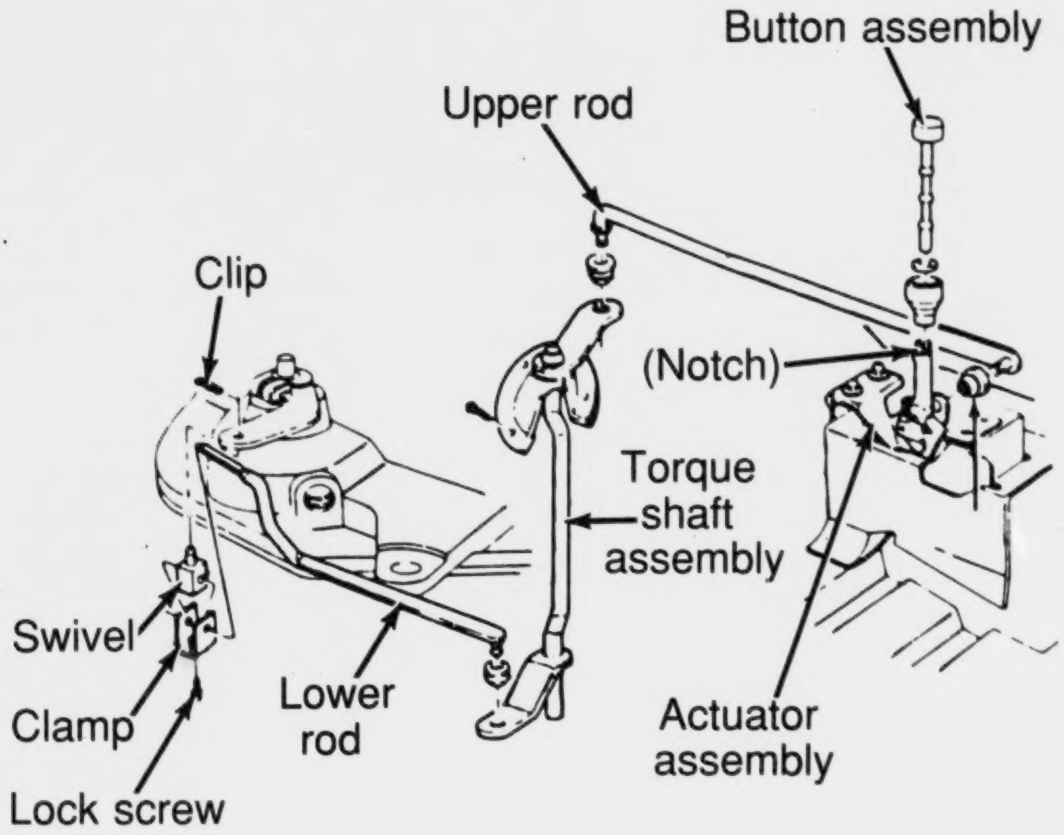
23. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

24. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

25. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

26. **Take** ___ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

Typical Console Shift Linkage



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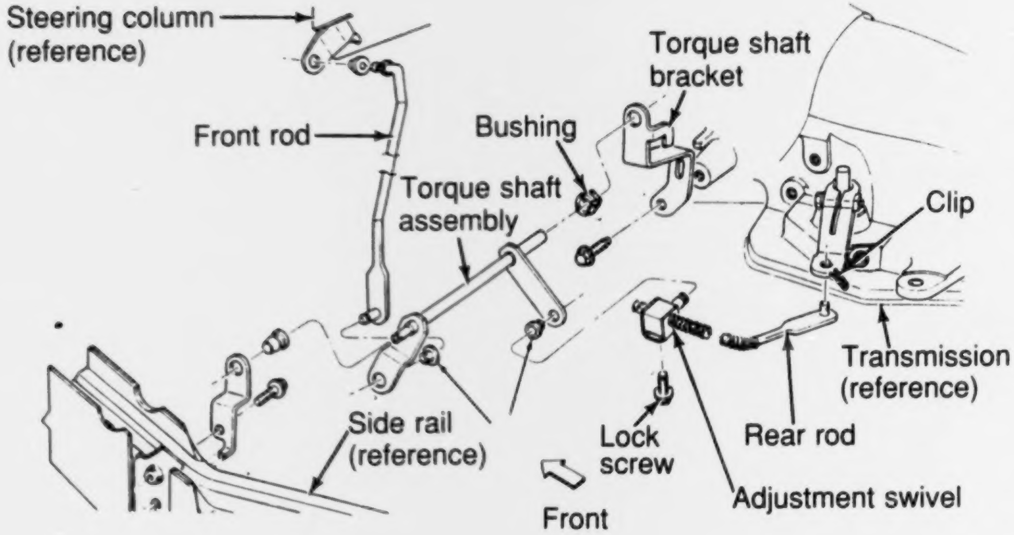
Typical Column Shift Linkage



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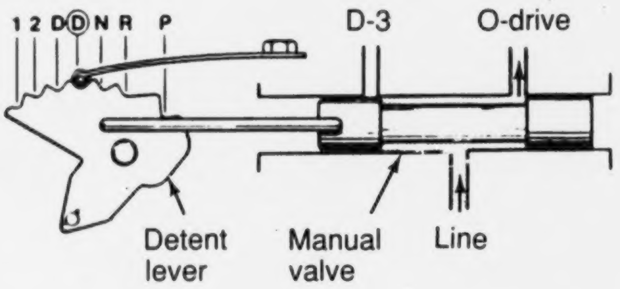
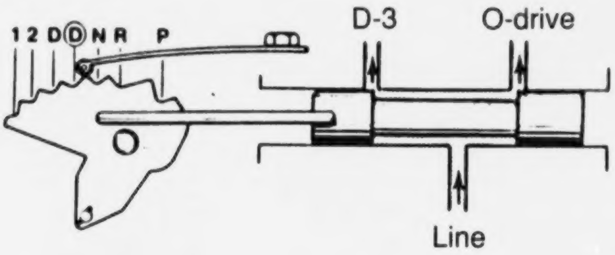
Misadjusted Manual Shift Linkage



Correct



Incorrect

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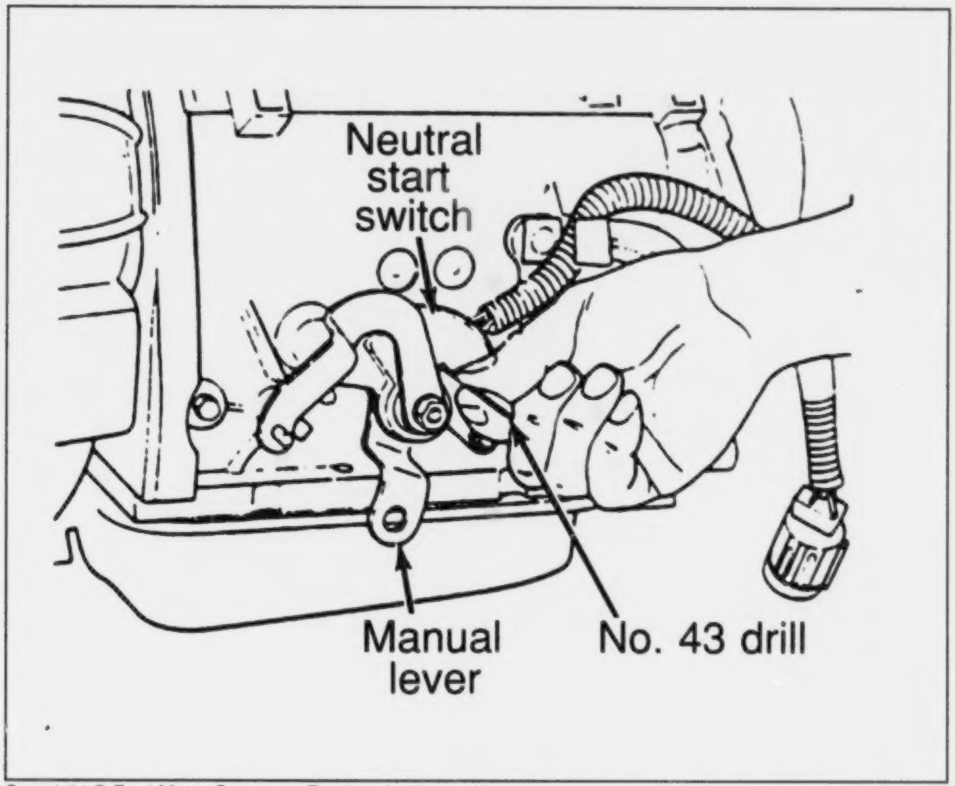
Neutral Safety Switch Adjustment



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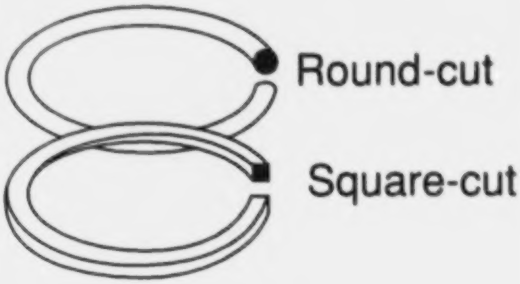
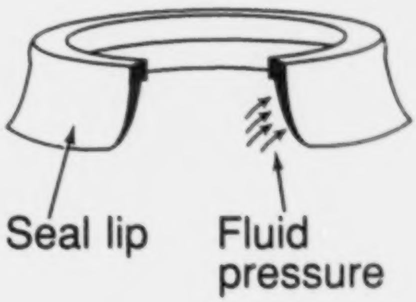
Seals

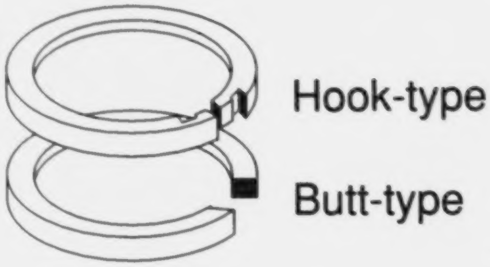
O-rings



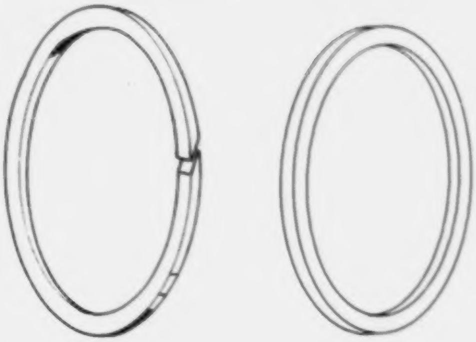
Lip-type seal



Metal rings



Teflon® rings



Scarf-cut

Solid ring

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WRITTEN TEST

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

3

Name ______________________________ Score __________

OBJECTIVE 1

Answer questions about the characteristics of rear-wheel drive automatic transmissions.

1. What kind of transmission is used in RWD vehicles?

____

2. What connects the transmission to the rear axle in RWD vehicles?

____

3. Where is the final drive/differential assembly located? How is it linked to the transmission?

____

____

4. How is the RWD vehicle pushed?

____

____

____

5. Why does RWD design create more stable movement than a FWD vehicle?

____

____

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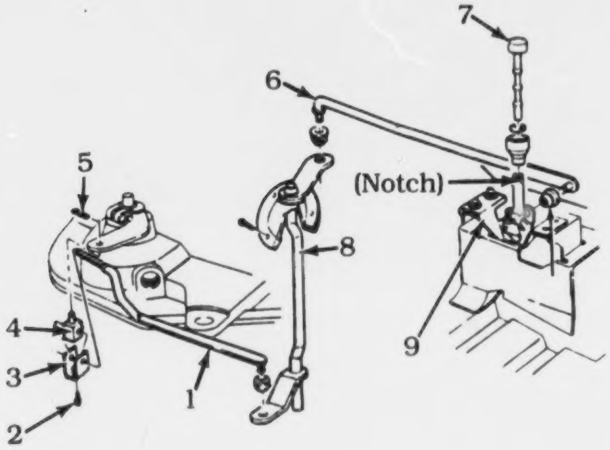
OBJECTIVE 2 **Label the parts of a typical console shift-linkage arrangement on a rear-wheel drive transmission.** Write the correct part names in the blanks provided below the following illustration.



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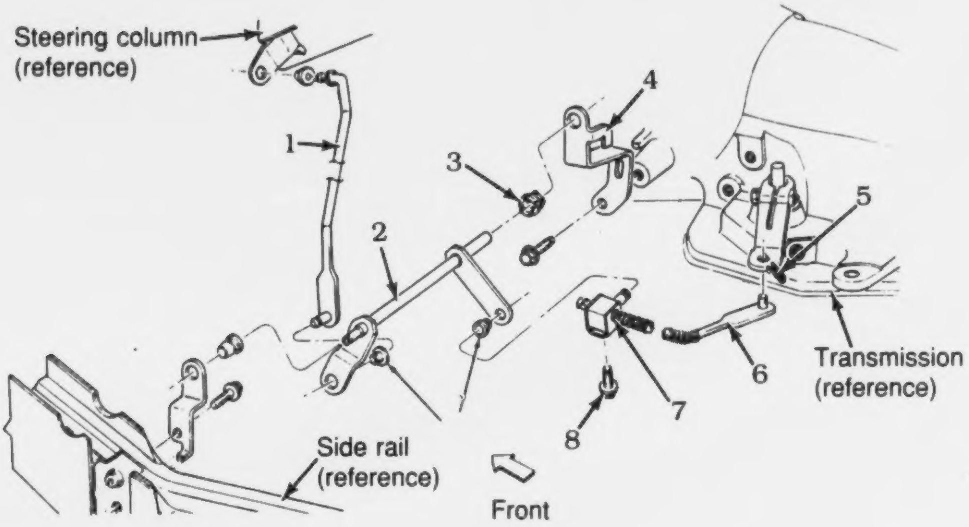
1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________

May be photocopied for student use.

OBJECTIVE 3 **Label the parts of a typical column shift linkage on a rear-wheel drive transmission.** Write the correct part names in the blanks provided below the following illustration.



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1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________

OBJECTIVE 4 **Describe the functions of various types of automatic transmission linkages and controls.**

1. throttle valve linkage (TV linkage) ______________________
2. manual shift linkage ______________________
3. kickdown linkage ______________________

May be photocopied for student use.

4. neutral safety switch ____________________

____

5. vacuum regulator valve ____________________

____

OBJECTIVE 5

List indicators of improper linkage adjustment.

Throttle valve linkage (List three.)

1. ____________________
2. ____________________
3. ____________________

Manual shift linkage (List four.)

1. ____________________
2. ____________________
3. ____________________
4. ____________________

Kickdown linkage (List two.)

1. ____________________
2. ____________________

Neutral safety switch (List one.)

1. ____________________

OBJECTIVE 6

Name terms associated with replacement seals. In each blank, write the term defined.

Pertains to the angle at which a Teflon® or metal seal is cut; the seal is split *straight* across its face

1. ____________________

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Flat seal, usually of paper, cork, rubber, plastic, or synthetic materials, placed between two parts with irregular surfaces to ensure proper sealing

2. ______________________________

Ability of a gasket to conform to surface irregularities

3. ______________________________

Gasket, such as a common plain paper gasket, that can be compressed less than 20 percent

4. ______________________________

A metal ring with ends connected by a hook

5. ______________________________

Lip-type seal with a rigid exterior housing; the flexible inner lip is bonded to the metal

6. ______________________________

Round ring that is pressed into grooves to provide sealing action

7. ______________________________

Room-temperature vulcanizing sealant that sets up in the presence of air; sometimes used in place of a gasket to seal covers attached to engine or transmission

8. ______________________________

Pertains to the angle at which a Teflon® seal is cut; the seal is split *diagonally* across its face

9. ______________________________

Device that prevents oil leakage around a moving part

10. ______________________________

Gasket that can be compressed more than 20 percent, such as a cork/rubber composition gasket

11. ______________________________

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OBJECTIVE 7

Label bushings, thrust bearings, and thrust washers typically used on modern transmissions. Your instructor will display ten (10) bushings, thrust bearings, and thrust washers and will number each. Write the correct names after the corresponding numbers.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

OBJECTIVE 8

List reasons why a specified amount of endplay is necessary in automatic transmissions.

1. ____
2. ____
3. ____

OBJECTIVE 9

State reasons for endplay adjustment.

1. ____
2. ____

OBJECTIVES 10-12

Evaluated on Job Sheets 1-3.

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LAP SHEET

SERVICING TORQUE CONVERTER AND OIL PUMP

4

Check the blank as you complete each step.

1. **Take** ___ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.
2. **Read** ___ the introduction, unit objective, and specific objectives.
3. **Do** ___ the focus assignments.
4. **Stop** ___ and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.
5. **Study** ___ the Information Sheet, Objectives 1 and 2.

Optional: Ask ___ your instructor to show you an actual torque converter, both assembled on a vehicle and disassembled on the bench.

6. **Study** ___ the Information Sheet, Objective 3.
7. **Study** ___ the Information Sheet, Objective 4. Ask your instructor to explain the "how" of each advantage.
8. **Study** ___ the Information Sheet, Objective 5.

Optional: Ask ___ your instructor to show you examples of conventional and lockup torque converters.

9. **Study** ___ the Information Sheet, Objective 6. Ask your instructor to explain the "how" of each advantage.
10. **Study** ___ the Information Sheet, Objective 7. Ask your instructor to explain the "how" of each advantage.
11. **Study** ___ the Information Sheet, Objective 8. Notice the differences and the similarities among the three oil pumps.
12. **Study** ___ the Information Sheet, Objectives 9 through 11.

13. **Learn** ___ how to use any required specialty tools.

14. **Locate** ___ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

15. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

16. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

17. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

18. **Locate** ___ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

19. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

20. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

21. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

22. **Locate** ___ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

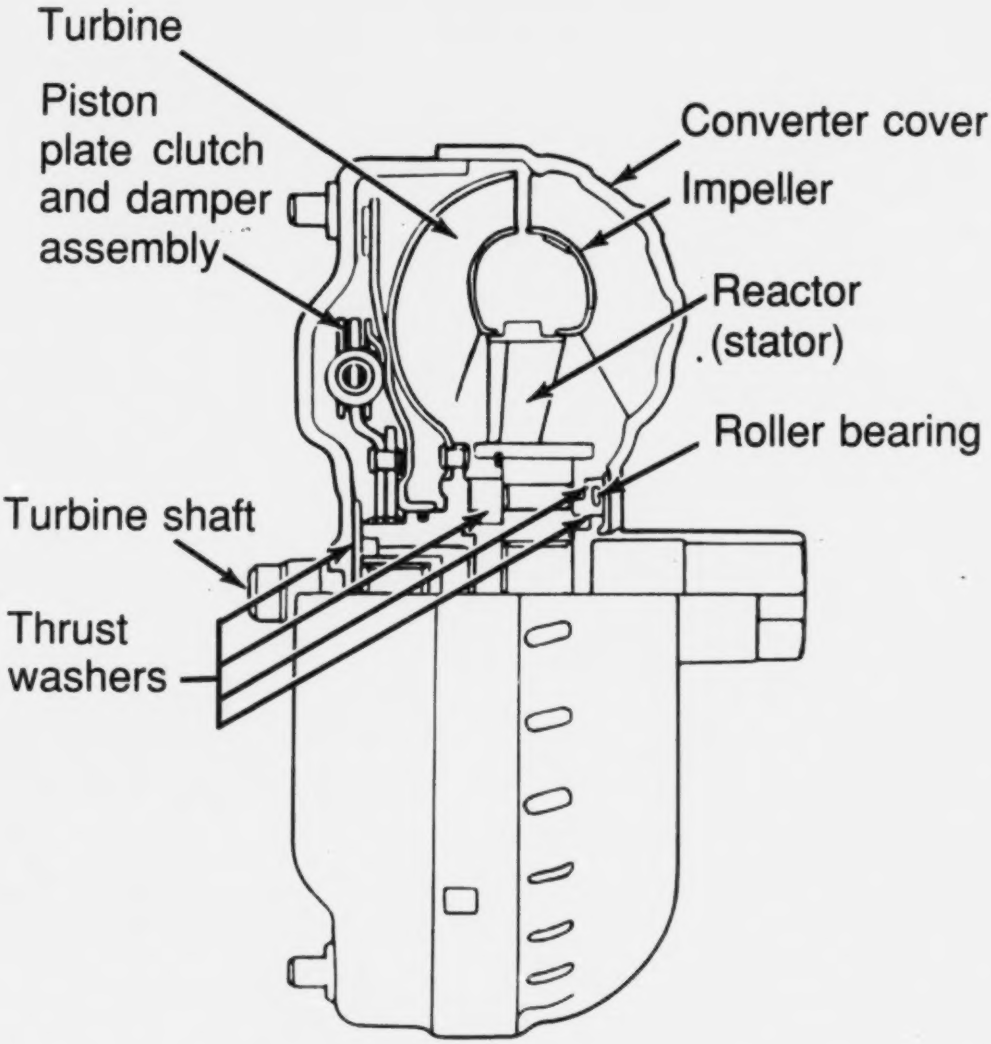
23. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

24. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

25. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

26. Take ___ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

Torque Converter Assembly (Cut-Away View)



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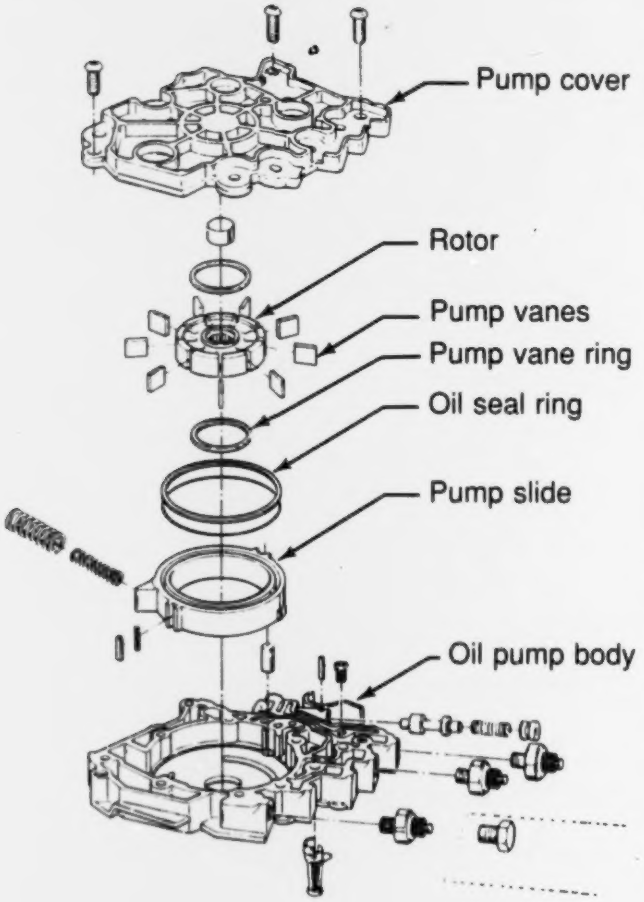
TM 2

Variable-Output, Vane-Type Oil Pump



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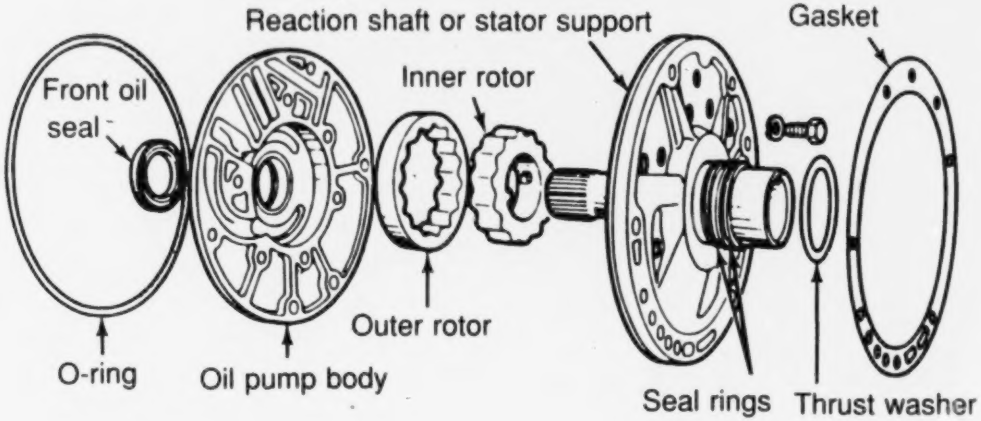
Rotor Oil Pump



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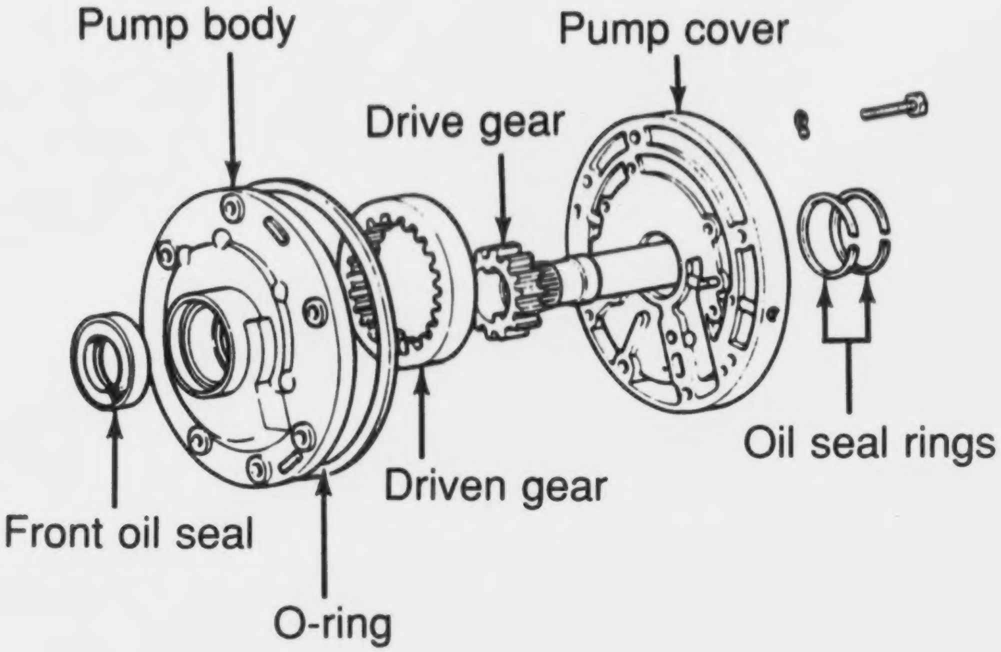
Gear Oil Pump



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INSTRUCTOR'S RESOURCE PACKAGE - Automatic Transmission/Transaxle Specialist
TRANSPARENCY MASTER 4 - **CIMC** - 4 - 11

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WRITTEN TEST

SERVICING TORQUE CONVERTER AND OIL PUMP

4

Name ______________________ Score __________

OBJECTIVE 1

Describe the primary functions of the torque converter.

1. ______________________________

____

2. ______________________________

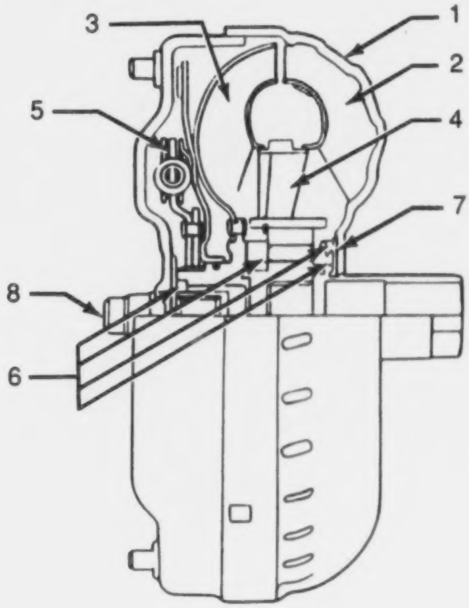
____

3. ______________________________

____

OBJECTIVE 2

Label the components of a cut-away view of a lockup torque converter assembly. Write the names on the blanks below the illustration.



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1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________

OBJECTIVE 3

Match torque converter components with their descriptions/functions. Write the letter of the answer in the blank. Each letter will be used twice.

A. torque converter housing
B. flexplate
C. impeller
D. turbine
E. stator
F. torque converter clutch
G. vane

_____ 1. One of several thin, curved fins or blades

_____ 2. Improves oil circulation inside the torque converter, making use of all the force produced in the moving oil

_____ 3. Driving fan

_____ 4. Produces rotary motion by reacting to the current of oil driven to it by the impeller

_____ 5. Small wheel-like device between the impeller and turbine

_____ 6. Eliminates slippage

_____ 7. Rigid metal component bolted to the flexplate, which in turn is bolted to the crankshaft

_____ 8. Transfers crankshaft rotation to the torque converter shell

_____ 9. Single-plate lockup clutch that locks to the input shaft

_____ 10. Directs fluid flow and facilitates rotation of the impeller, stator, or turbine to which it is attached

_____ 11. Driven fan splined to the input shaft of the automatic transmission

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_____ 12. Encloses and seals in the parts of the torque converter

_____ 13. Rigid metal component that, with the torque converter, serves as a flywheel, providing the inertia to keep the crankshaft turning smoothly during periods when no power is applied

_____ 14. Produces oil movement inside the converter when the vehicle is running

OBJECTIVE 4 **List advantages of the torque converter.**

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

OBJECTIVE 5 **Describe conventional and lockup torque converters.**

1. Conventional

____

____

____

____

____

____

May be photocopied for student use.

2. Lockup

____

____

____

____

____

____

OBJECTIVE 6

List the advantages of a lockup torque converter over a conventional torque converter.

1. ____

____

2. ____

____

3. ____

____

OBJECTIVE 7

Explain the advantages of the piston lockup-converter clutch over the centrifugal lockup-converter clutch.

1. ____

____

2. ____

____

3. ____

4. ____

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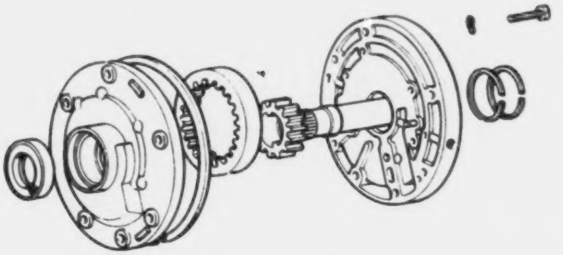
OBJECTIVE 8

Identify the three types of commonly used oil pumps. Write the correct name under each illustration.



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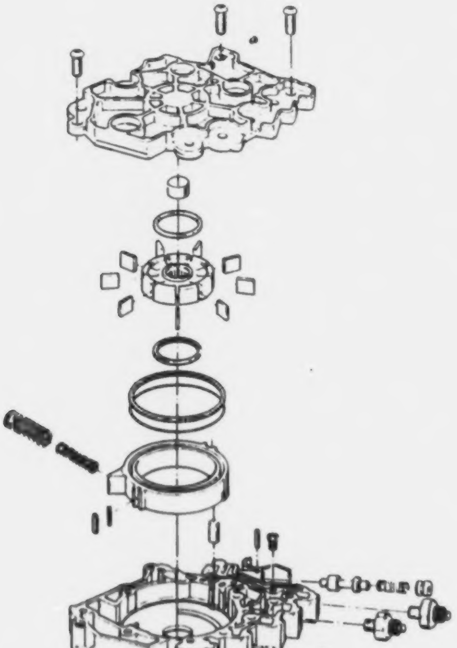
1. ______________________________



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2. ______________________________

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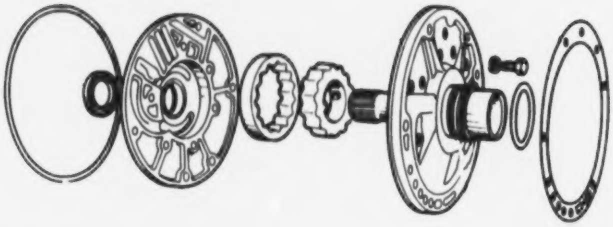

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3. ______________________________

OBJECTIVE 9

State the functions of the transmission oil pump.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

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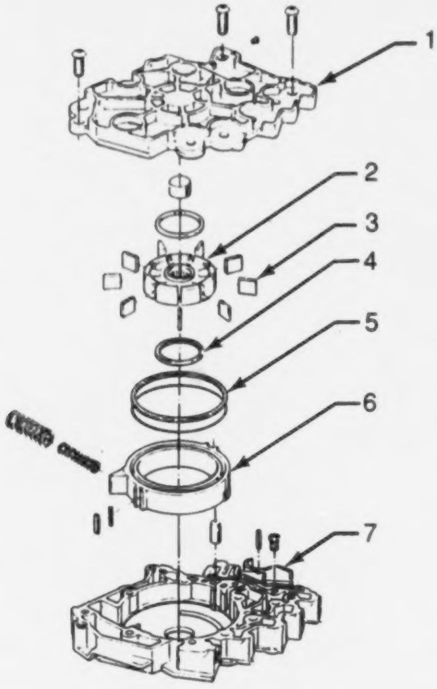
OBJECTIVE 10 **Label the parts of a variable-output, vane-type oil pump.** Write the correct names on the blanks below the illustration.



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1. ______________________ 5. ______________________

2. ______________________ 6. ______________________

3. ______________________ 7. ______________________

4. ______________________

OBJECTIVE 11 **State indications of possible torque converter problems.** State three (3) reasons.

1. ____

2. ____

3. ____

OBJECTIVES 12-14 **Evaluated on Job Sheets 1-3.**

254

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LAP SHEET

SERVICING GEAR TRAIN/GEARSETS

5

Check the blank as you complete each step.

1. **Take** _____ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

2. **Read** _____ the introduction, unit objective, and specific objectives.

3. **Do** _____ the focus assignments.

4. **Stop** _____ and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.

5. **Study** _____ the Information Sheet, Objective 1. Ask your instructor to show you examples of each of the gears illustrated.

Optional: Make _____ a display of the various gears used in automatic transmissions/transaxles.

6. **Study** _____ the Information Sheet, Objective 2.

Optional: Ask _____ your instructor to show you an example of a simple planetary gearset.

7. **Study** _____ the Information Sheet, Objective 3.

Optional: Ask _____ your instructor for a way to help you remember the results of simple planetary gearset combinations.

8. **Study** _____ the Information Sheet, Objective 4.

Optional: Ask _____ your instructor to show you an example of gear train assemblies.

9. **Study** ____ the Information Sheet, Objective 5.

Optional: Ask ____ your instructor to show or explain how oil is delivered to the various clutch packs.

10. **Study** ____ the Information Sheet, Objective 6.

Optional: Ask ____ your instructor to show you examples of cracked and damaged seals.

11. **Study** ____ the Information Sheet, Objective 7.

Optional: Ask ____ your instructor to show you examples of dry or worn bushings and examples of damaged shafts.

12. **Study** ____ the Information Sheet, Objective 8.

Optional: Ask ____ your instructor to show you examples of parking pawl assemblies.

13. **Ask** ____ your instructor to show you how to identify worn or damaged gear train/gearset parts.

14. **Learn** ____ how to use any required specialty tools.

15. **Locate** ____ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

16. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

17. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

18. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

19. **Locate** ____ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

20. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

21. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

22. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

23. **Locate** ____ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

24. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

25. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

26. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

27. **Locate** ____ the procedure(s) for Job Sheet 4 in the service manual for the make and model vehicle you are servicing.

28. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 4. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

29. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

30. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

31. **Locate** ____ the procedure(s) for Job Sheet 5 in the service manual for the make and model vehicle you are servicing.

32. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 5. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

33. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

34. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

35. **Locate** ____ the procedure(s) for Job Sheet 6 in the service manual for the make and model vehicle you are servicing.

36. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 6. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

37. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

38. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

39. **Locate** ____ the procedure(s) for Job Sheet 7 in the service manual for the make and model vehicle you are servicing.

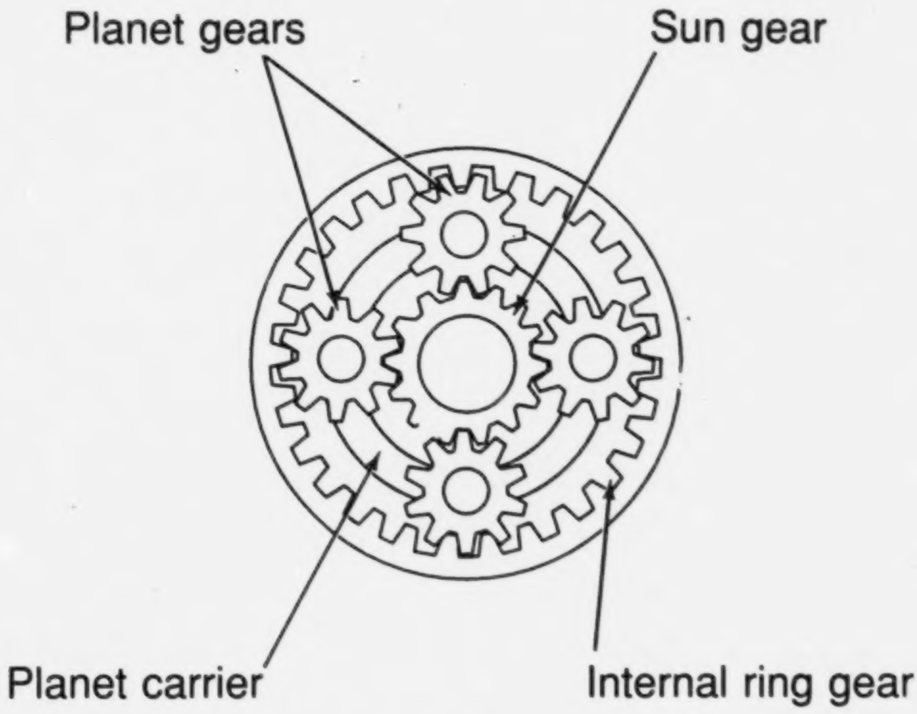
40. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 7. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

41. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

42. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

43. **Take** ____ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

Planetary Gearset



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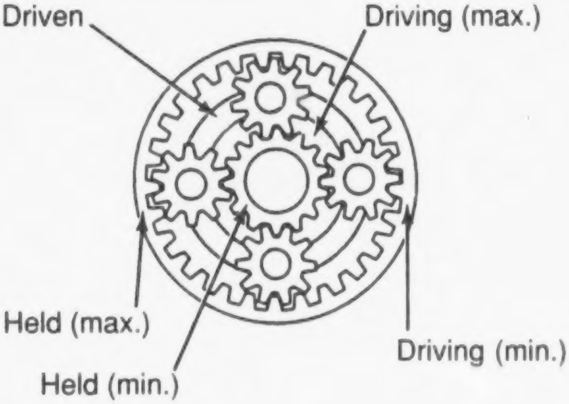
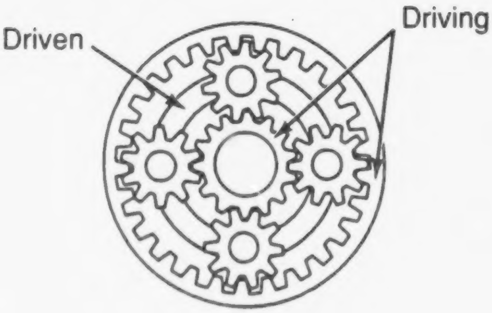
Planetary Gearset Power Flow

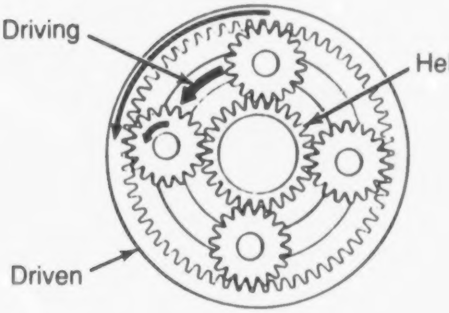
Forward reduction



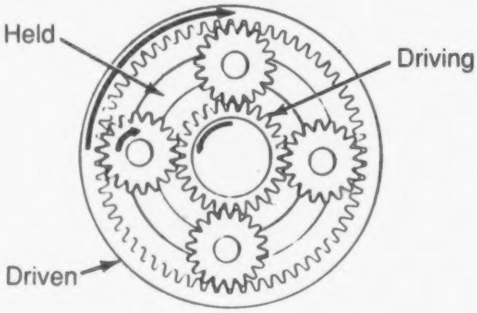
Direct drive



Overdrive



Reverse



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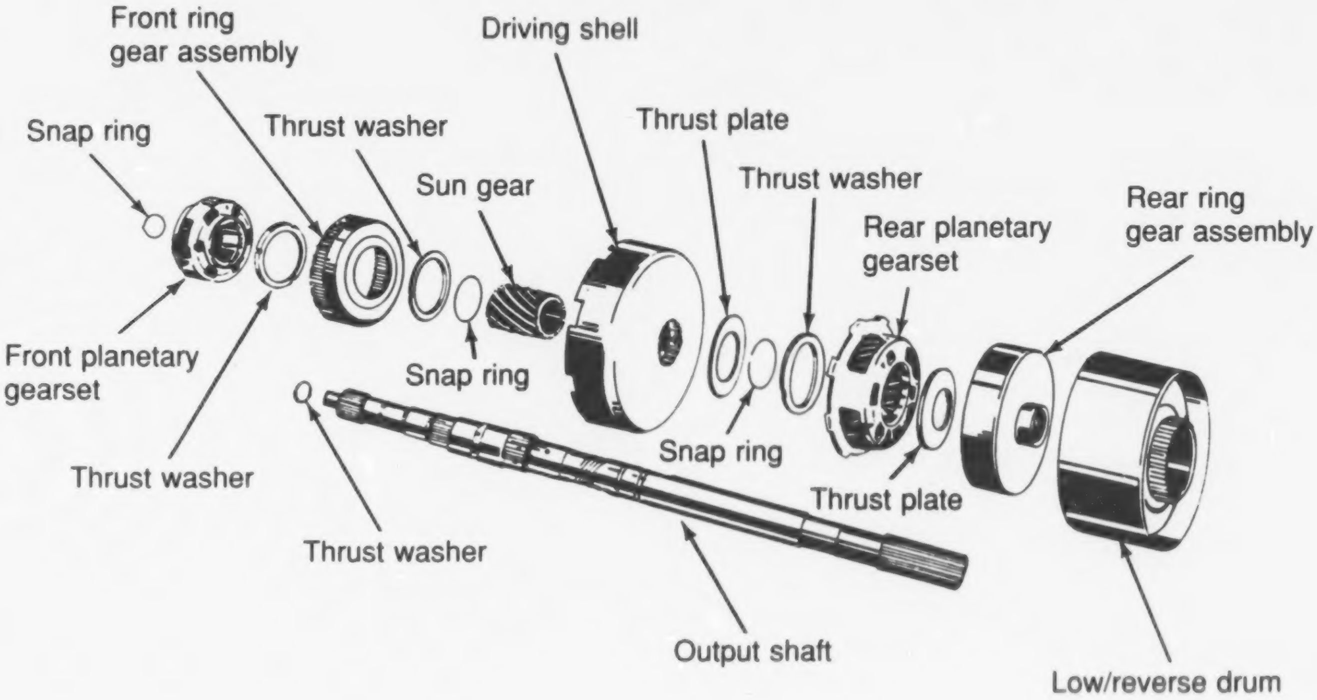
Planetary Gear Train Assembly



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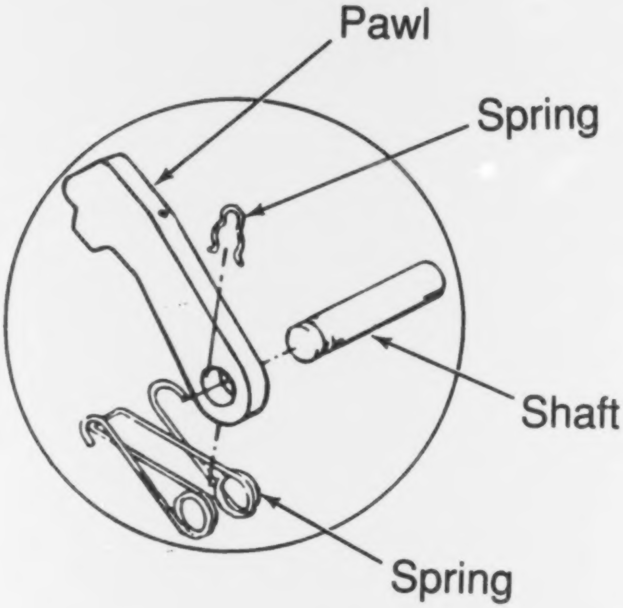
Parking Pawl Assembly



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WRITTEN TEST

SERVICING GEAR TRAIN/GEARSETS

5

Name ______________________________ Score __________

OBJECTIVE 1

Match types of gears and gearsets with their characteristics. Write the correct letters in the blanks.

A. idler gear
B. spur gear
C. helical gear
D. rack and pinion gearset
E. planetary gearset
F. bevel gearsets
G. ring gear
H. worm and worm gear
I pinion gear

____ 1. Group of gears that orbit or circle a central gear

____ 2. Gear with teeth at an angle to gear axis

____ 3. Coiled or cylindrically shaped gear, whose diameter is usually only slightly larger than its shaft, and a circular helical or spur gear; used to drive elements whose axes are at right angles

____ 4. A third gear meshed between two (usually larger) gears

____ 5. Held in place by the planet carrier and ring gear

____ 6. A flat box gear and a pinion gear used to change rotary motion to linear travel perpendicular to the axis of rotation

____ 7. Gear in which teeth are cut in a cone shape to connect two shafts rotating at an angle to each other

____ 8. Gear with teeth parallel to the gear axis

____ 9. Gear that resembles a ring rather than a disc; sometimes called an annulus gear

____ 10. Any gear considerably smaller than the one with which it meshes

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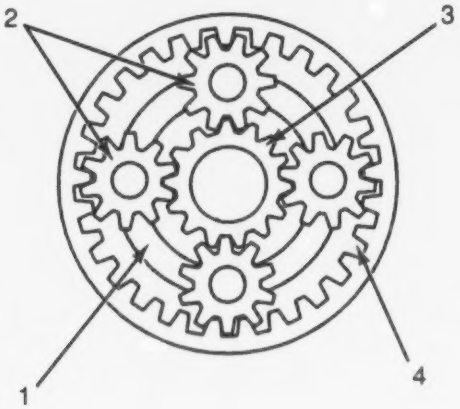
OBJECTIVE 2

Label the parts of a simple planetary gearset. Write the correct names after the corresponding numbers.

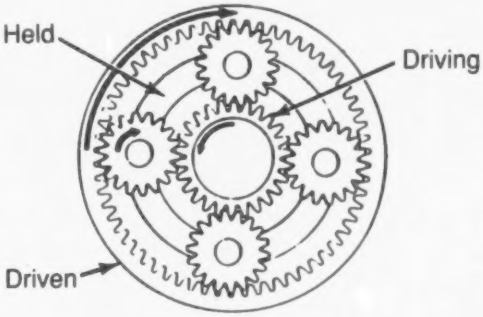


1. ____________________ 3. ____________________

2. ____________________ 4. ____________________

OBJECTIVE 3

Explain planetary gearset power flow. Write the name of the type of power flow represented by each figure.



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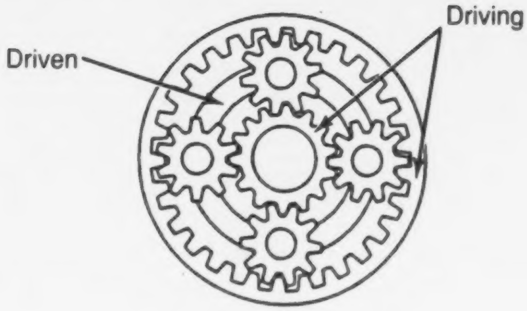
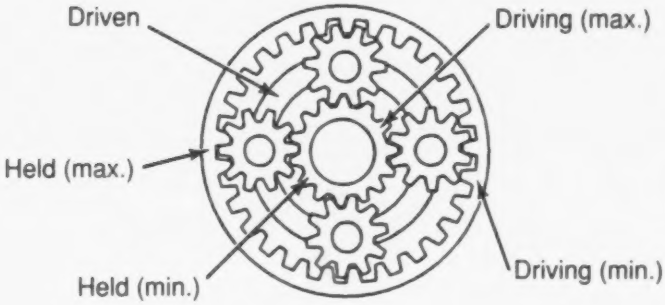
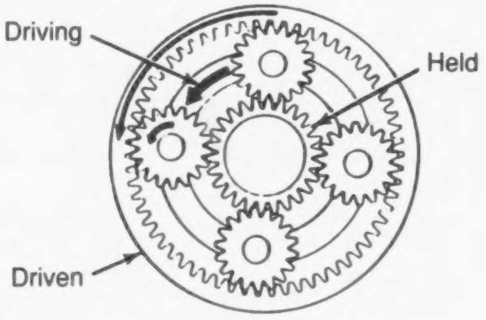
1. ____



2. ______________________________



3. ______________________________



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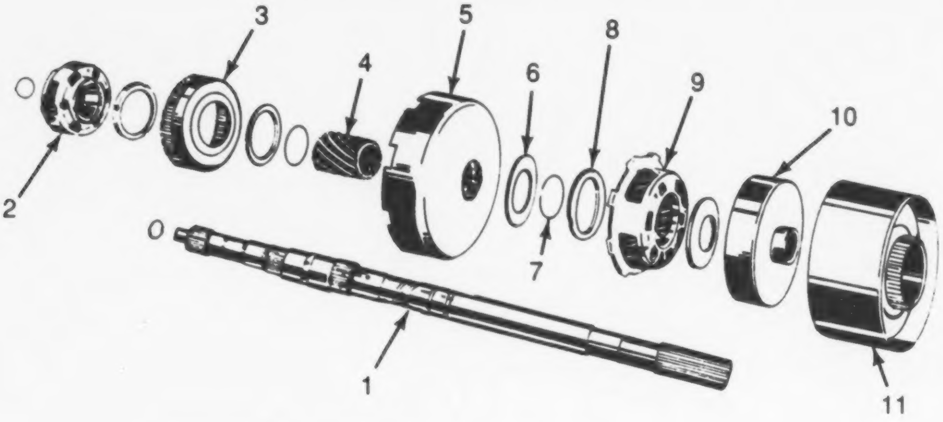
4. ______________________________

OBJECTIVE 4

Label the parts of a typical planetary gear train assembly.
Write the correct names after the corresponding numbers.



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1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________

OBJECTIVE 5

State the purposes of holes in shafts.

1. ____________
2. ____________
3. ____________

OBJECTIVE 6

State reasons for replacing oil delivery seal rings.

1. ____________
2. ____________
3. ____________

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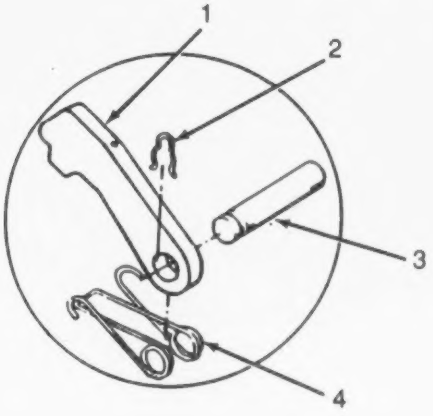
OBJECTIVE 7 **State reasons for replacing bushings.**

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

OBJECTIVE 8 **Label the parts of a parking pawl assembly.** Write the correct names after the corresponding numbers.



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1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

OBJECTIVES 9-15 **Evaluated on Job Sheets 1-7.**

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LAP SHEET

SERVICING FRICTION UNITS AND COOLER

6

Check the blank as you complete each step.

1.	**Take**	___ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.
2.	**Read**	___ the introduction, unit objective, and specific objectives.
3.	**Do**	___ the focus assignments.
4.	**Stop**	___ and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.
5.	**Study**	___ the Information Sheet, Objective 1.
Optional:	**Locate**	___ the clutch assembly on the transmission on which you will be working.
6.	**Study**	___ the Information Sheet, Objectives 2 and 3.
Optional:	**Locate**	___ the clutch return spring on the transmission on which you will be working.
7.	**Study**	___ the Information Sheet, Objectives 4 and 5.
Optional:	**Practice**	___ measuring clearances with a feeler gauge.
8.	**Study**	___ the Information Sheet, Objective 6.
Optional:	**Locate**	___ a sprag clutch on the transmission on which you will be working (if applicable).
9.	**Study**	___ the Information Sheet, Objective 7.
Optional:	**Locate**	___ a roller clutch on the transmission on which you will be working (if applicable).

10. **Study** ___ the Information Sheet, Objective 8.

11. **Study** ___ the Information Sheet, Objective 9.

Optional: Locate ___ a band and servo assembly on the transmission on which you will be working (if applicable).

12. **Ask** ___ your instructor to show you how to handle clutch pack components.

13. **Learn** ___ how to use a transmission jack safely and properly. Ask your instructor to demonstrate its use.

14. **Learn** ___ how to use any required specialty tools.

15. **Ask** ___ your instructor to review with you methods for removing and replacing parts in sequence to facilitate reassembly and to prevent them from becoming lost.

16. **Locate** ___ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

17. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

18. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

19. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

20. **Locate** ___ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

21. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

22. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

23. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

24. **Locate** ___ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

25. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

26. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

27. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

28. **Locate** ___ the procedure(s) for Job Sheet 4 in the service manual for the make and model vehicle you are servicing.

29. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 4. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

30. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

31. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

32. **Locate** ___ the procedure(s) for Job Sheet 5 in the service manual for the make and model vehicle you are servicing.

33. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 5. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

34. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

35. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

36. **Locate** ___ the procedure(s) for Job Sheet 6 in the service manual for the make and model vehicle you are servicing.

37. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 6. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

38. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

39. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

40. **Locate** ___ the procedure(s) for Job Sheet 7 in the service manual for the make and model vehicle you are servicing.

41. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 7. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

42. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

43. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

44. **Locate** ___ the procedure(s) for Job Sheet 8 in the service manual for the make and model vehicle you are servicing.

45. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 8. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

46. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

47. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

48. **Locate** ___ the procedure(s) for Job Sheet 9 in the service manual for the make and model vehicle you are servicing.

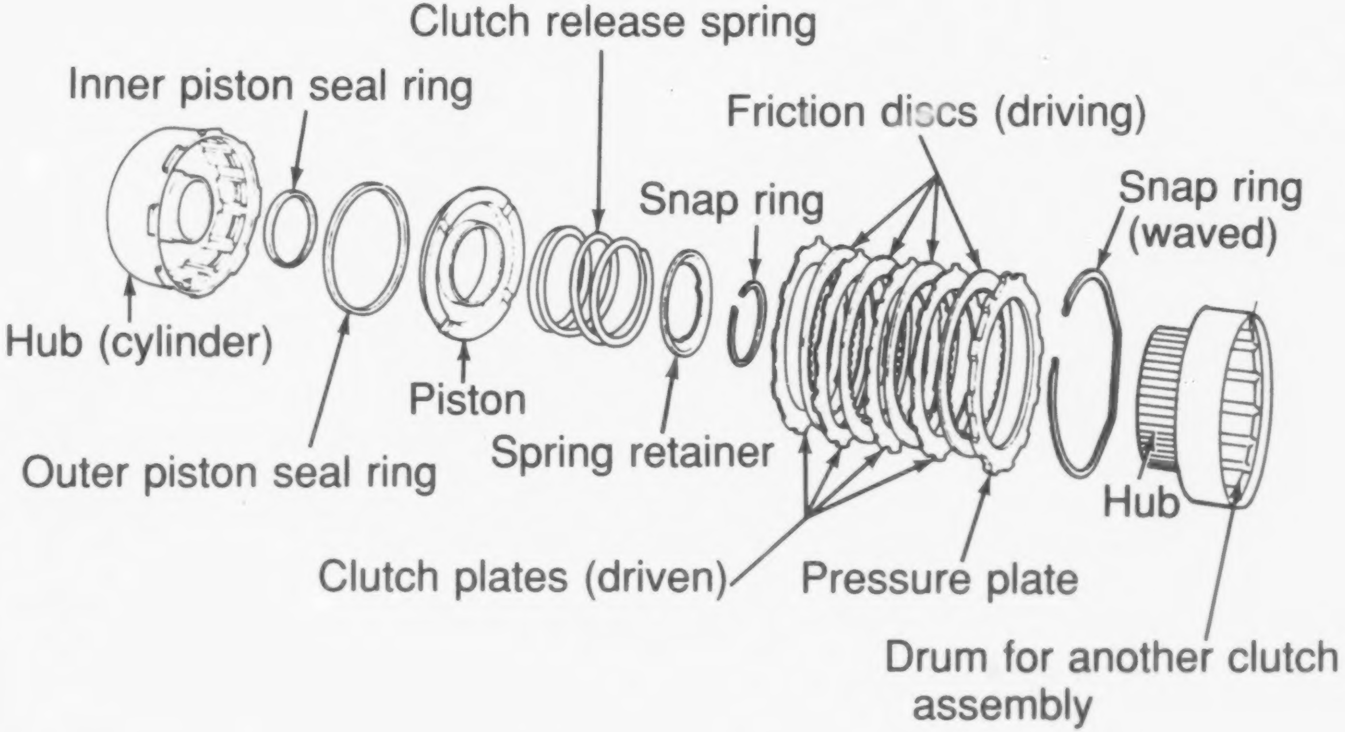
49. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 9. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

50. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

51. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

52. **Take** ___ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

Multiple-Disc Clutch Assembly Components



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INSTRUCTOR'S RESOURCE PACKAGE - Automatic Transmission/Transaxle Specialist
TRANSPARENCY MASTER 1 - **CIMC** - 6 - 7

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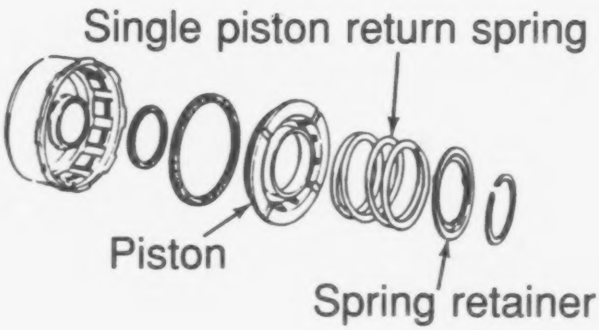
Piston Return Spring Arrangements

Single Coil Spring



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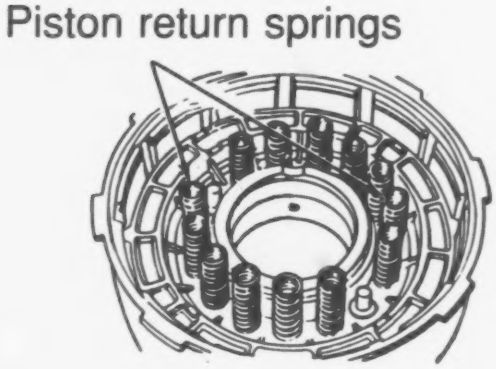
Multiple Coil Springs



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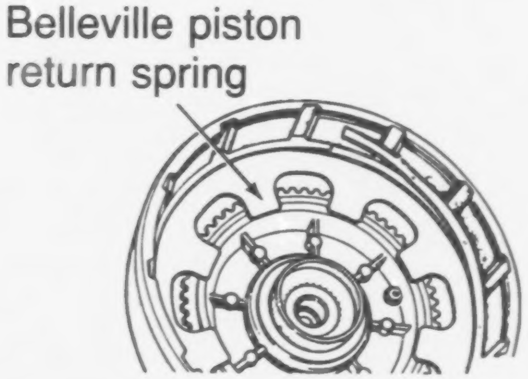
Diaphragm Spring (Belleville Spring)



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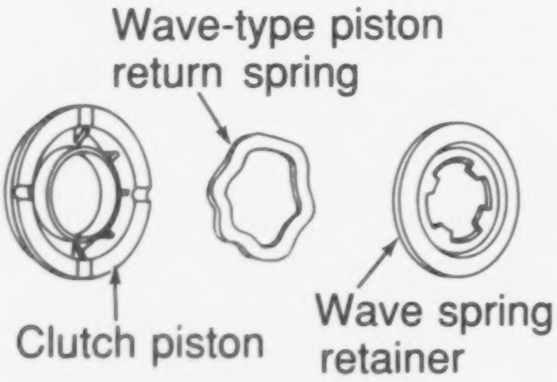
Wave-Washer Spring



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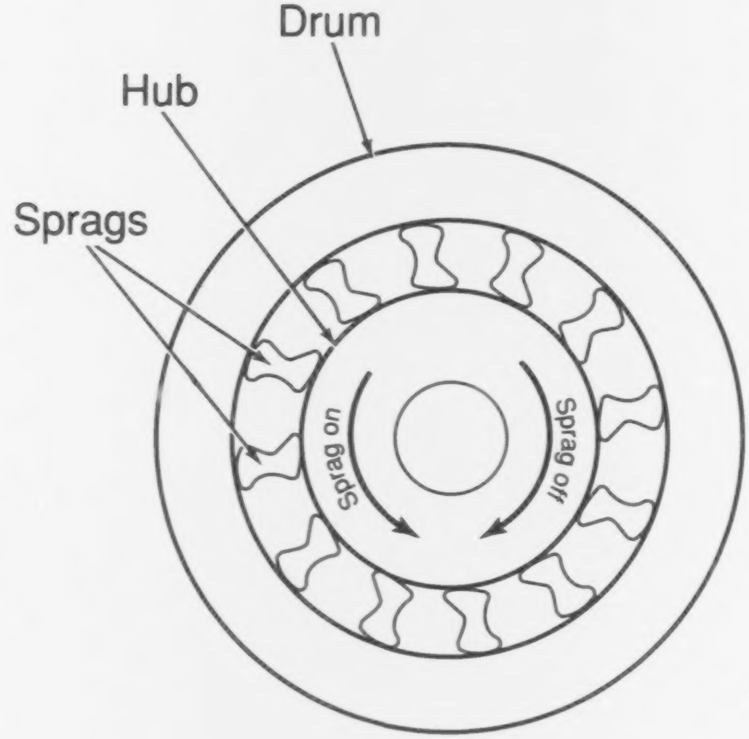
One-Way Sprag Clutch



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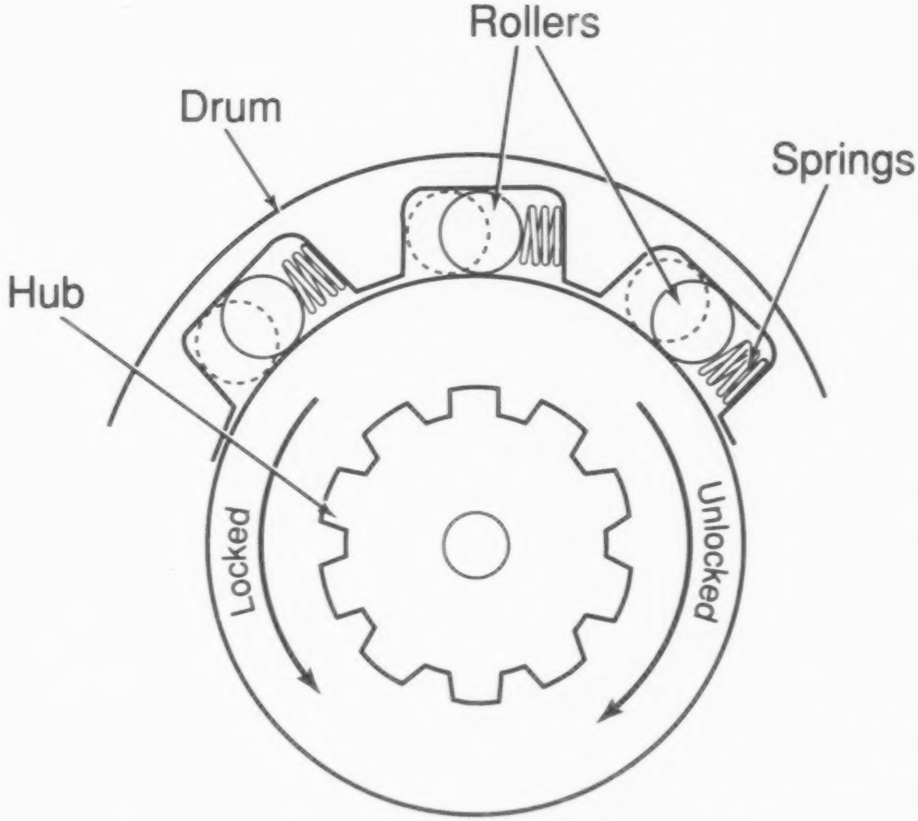
One-Way Roller Clutch



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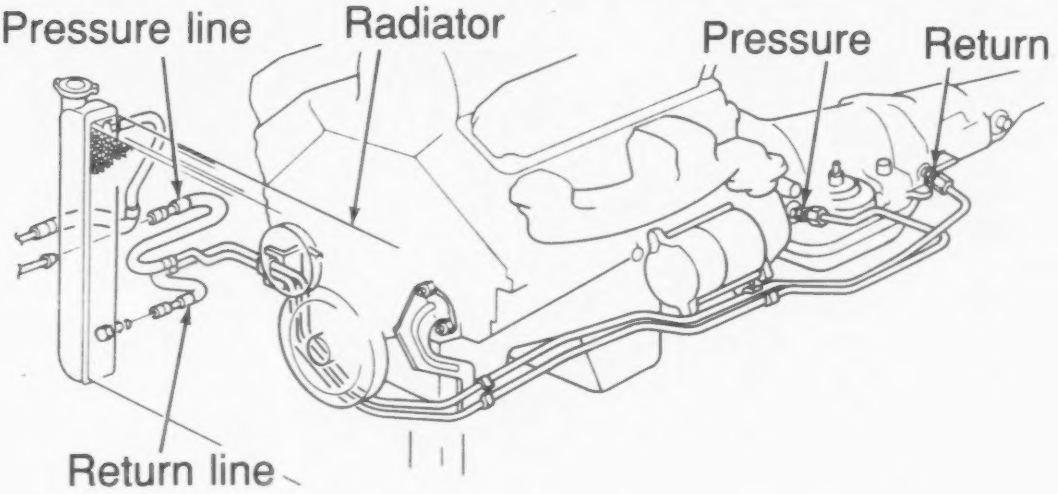
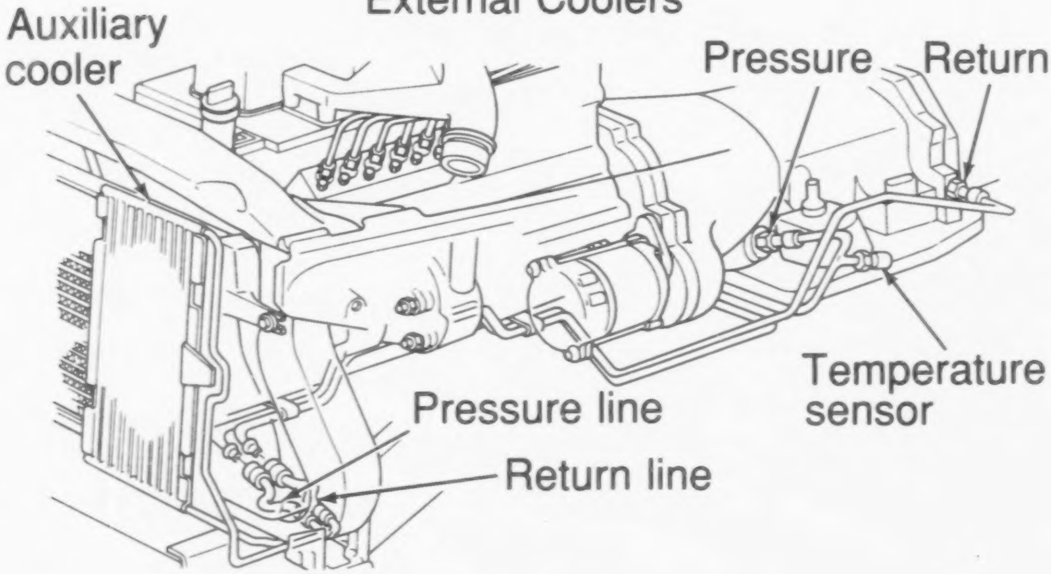
Internal and External Coolers

Internal Coolers



External Coolers



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WRITTEN TEST

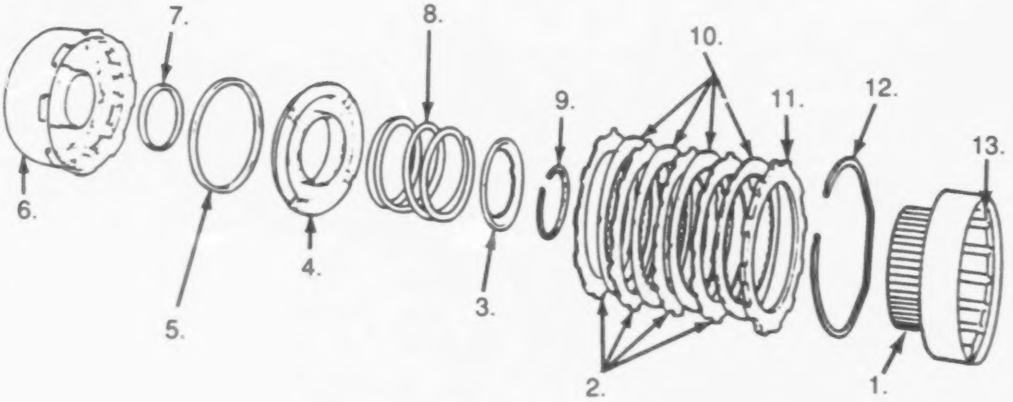
SERVICING FRICTION UNITS AND COOLER

6

Name ______________________________ Score __________

OBJECTIVE 1

Label the parts of a multiple-disc clutch assembly. Write the correct names after the corresponding numbers.



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1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________

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OBJECTIVE 2

State the functions of clutch assembly components.

1. clutch drum (clutch cylinder) ______
2. clutch hub ______
3. friction discs ______
4. clutch plates ______
5. clutch apply piston ______
6. pressure plate ______
7. clutch spring ______
8. piston seal ring ______
9. snap ring ______

OBJECTIVE 3

Describe types of piston return spring arrangements.

1. single coil spring ______
2. multiple coil springs ______

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3. diaphragm spring (Belleville spring) ____________________

____

____

4. wave-washer spring ____________________

____

____

OBJECTIVE 4

Explain clutch operation.

Disengaged

1. ____________________

____

2. ____________________

____

3. ____________________

____

Engaged

1. ____________________

____

2. ____________________

____

3. ____________________

____

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OBJECTIVE 5

Explain the importance of clutch pack clearances.

1. ______________________________

____

____

2. ______________________________

____

____

3. ______________________________

____

____

4. ______________________________

____

____

5. ______________________________

____

____

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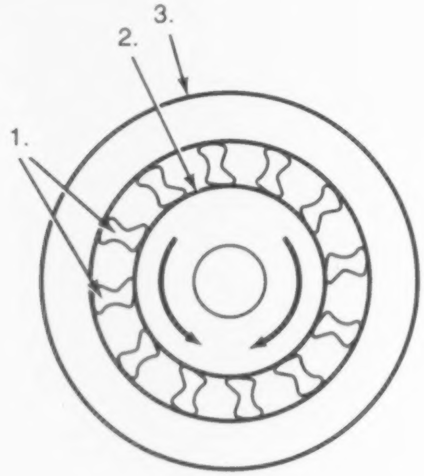
OBJECTIVE 6

Label the parts of a sprag clutch. Write the correct names after the corresponding numbers.

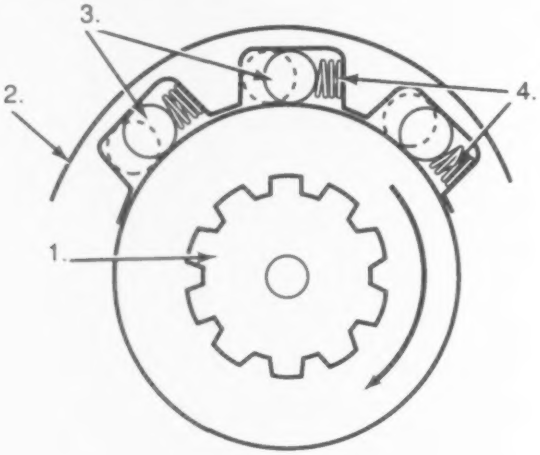


1. ____________________ 3. ____________________

2. ____________________

OBJECTIVE 7

Label the parts of a roller clutch. Write the correct names after the corresponding numbers.



1. ____________________ 3. ____________________

2. ____________________ 4. ____________________

5. Is the illustrated roller clutch in the locked or unlocked position? ____________________

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OBJECTIVE 8

Explain how sprag and roller clutches work.

Sprag clutch

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

Roller clutch

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

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OBJECTIVE 9

Label the parts of a typical band/servo assembly. Your instructor will display a typical band/servo assembly or its components and will number each part. Write the correct names after the corresponding numbers.

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________

OBJECTIVE 10

State the functions of band and servo components.

1. band ____________
2. band lining ____________
3. servo piston ____________
4. actuating rod ____________
5. band adjustment screw ____________
6. servo piston seals ____________
7. snap rings ____________

OBJECTIVE 11

State the functions of internal and external coolers.

____

____

____

____

____

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OBJECTIVE 12

Distinguish between descriptions of internal and external coolers. Write an "X" in the blank before the description of an *external* cooler.

_____ 1. A small sealed heat exchanger in the lower tank of downflow radiators or the outlet tank of crossflow radiators

_____ 2. A separate, small transmission radiator outside the engine radiator; cools transmission fluid on vehicles subject to heavy loads; heated fluid runs first through internal cooler and then through external cooler

OBJECTIVES 13-21

Evaluated on Job Sheets 1 - 9.

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LAP SHEET

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Check the blank as you complete each step.

1. Take ___ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

2. Read ___ the introduction, unit objective, and specific objectives.

3. Do ___ the focus assignments.

4. Stop ___ and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.

5. Study ___ the Information Sheet, Objective 1.

Optional: Check ___ under the hood of different makes and models of vehicles in your shop. Note the engine and transaxle configuration and position.

6. Study ___ the Information Sheet, Objective 2.

Optional: Ask ___ your instructor to show you examples of FWD gearshift linkage components.

Optional: Locate ___ the gearshift linkage on several different makes and models of front-wheel drive vehicles.

7. Study ___ the Information Sheet, Objective 3. Ask your instructor to provide examples and analogies, and to explain functions in greater detail.

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8. **Ask**	___	your instructor to show you examples of the various switches and linkages.
Optional: Locate	___	the various linkages and controls on a front-wheel drive vehicle.
9. **Study**	___	the Information Sheet, Objectives 4 and 5. Ask your instructor to provide examples and analogies, and to explain functions in greater detail.
Optional: Locate	___	drive link assembly components on various FWD shop vehicles.
10. **Study**	___	the Information Sheet, Objective 6. Study the transaxle drive link assembly wear points.
Optional: Locate	___	drive link assembly wear points on various FWD shop vehicles.
11. **Study**	___	the Information Sheet, Objective 7. Study the FWD axle shaft assembly.
Optional: Locate	___	the axle shaft assembly on various FWD shop vehicles.
12. **Study**	___	the Information Sheet, Objective 8.
Optional: Locate	___	the transaxle final drive and differential assembly on various FWD shop vehicles.
13. **Study**	___	the Information Sheet, Objective 9. Ask your instructor to show you examples of the various final drive arrangements and gear types.
Optional: Locate	___	and identify the final drive on various makes and models of FWD vehicles.
14. **Ask**	___	your instructor to show you how to locate the external seals and gaskets on a FWD vehicle.
15. **Ask**	___	your instructor to show you how to identify worn or damaged gear train/gearset parts.

May be photocopied for student use.

16. **Locate** ___ the flexplate, drive link and final drive assemblies on the vehicle(s) on which you will be working.

17. **Learn** ___ how to use a transmission jack safely and properly. Ask your instructor to demonstrate its use.

18. **Learn** ___ how to use any required specialty tools.

19. **Locate** ___ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

20. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

21. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

22. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

23. **Locate** ___ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

24. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

25. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

26. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

27. **Locate** ___ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

28. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

May be photocopied for student use.

29. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

30. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

31. **Locate** ___ the procedure(s) for Job Sheet 4 in the service manual for the make and model vehicle you are servicing.

32. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 4. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

33. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

34. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

35. **Locate** ___ the procedure(s) for Job Sheet 5 in the service manual for the make and model vehicle you are servicing.

36. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 5. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

37. **Practice** ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

38. **Stop** ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

39. **Locate** ___ the procedure(s) for Job Sheet 6 in the service manual for the make and model vehicle you are servicing.

40. **Ask** ___ your instructor to demonstrate the guidelines and procedures in Job Sheet 6. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

May be photocopied for student use.

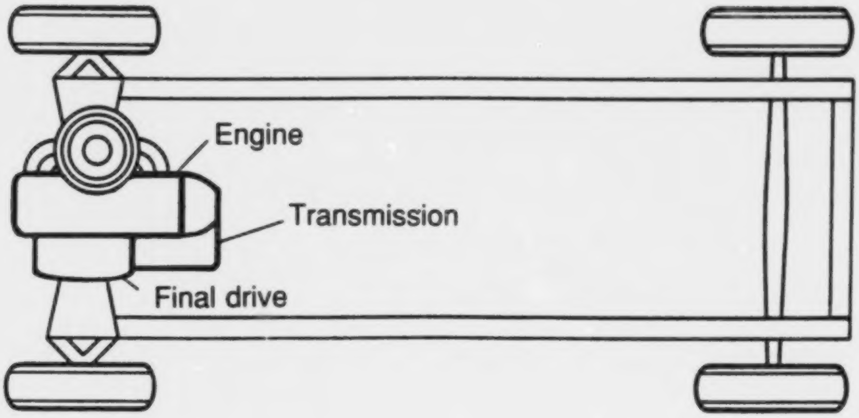
41. Practice ___ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

42. Stop ___ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

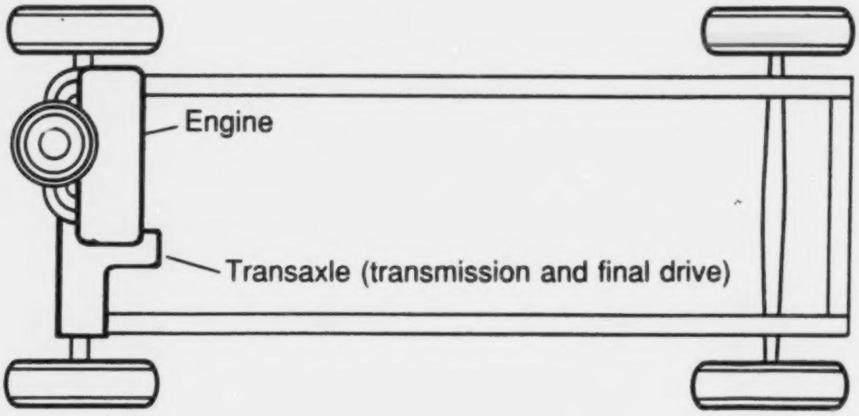
43. Take ___ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

May be photocopied for student use.

FWD Transaxle/Transmission



FWD transmission



FWD transaxle

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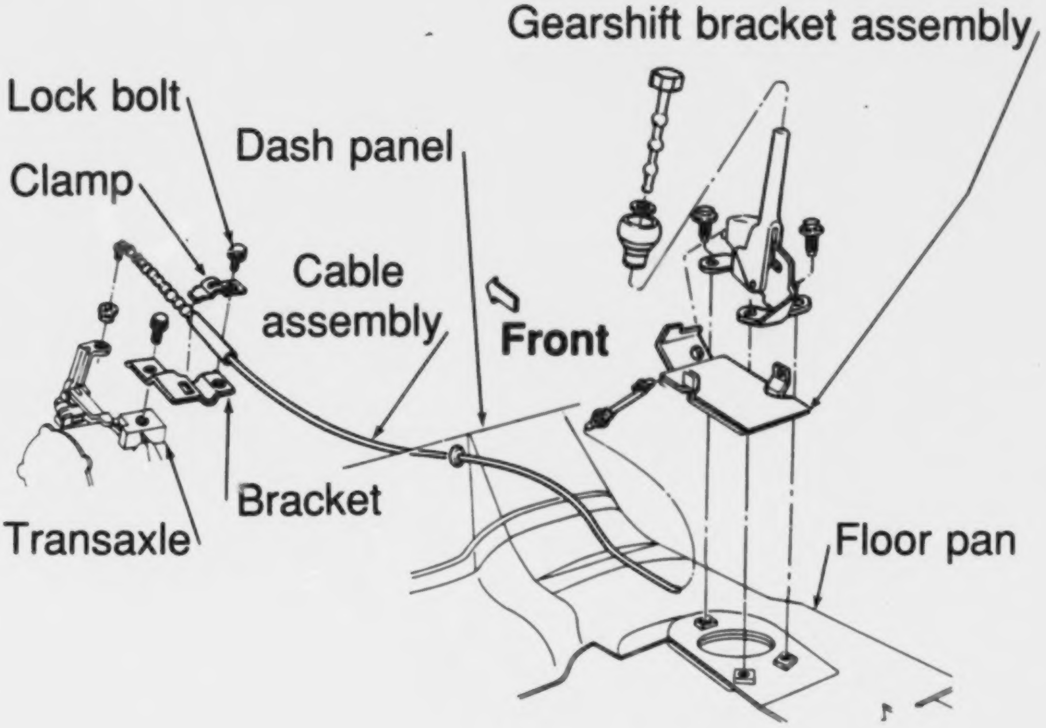
FWD Gearshift Linkage



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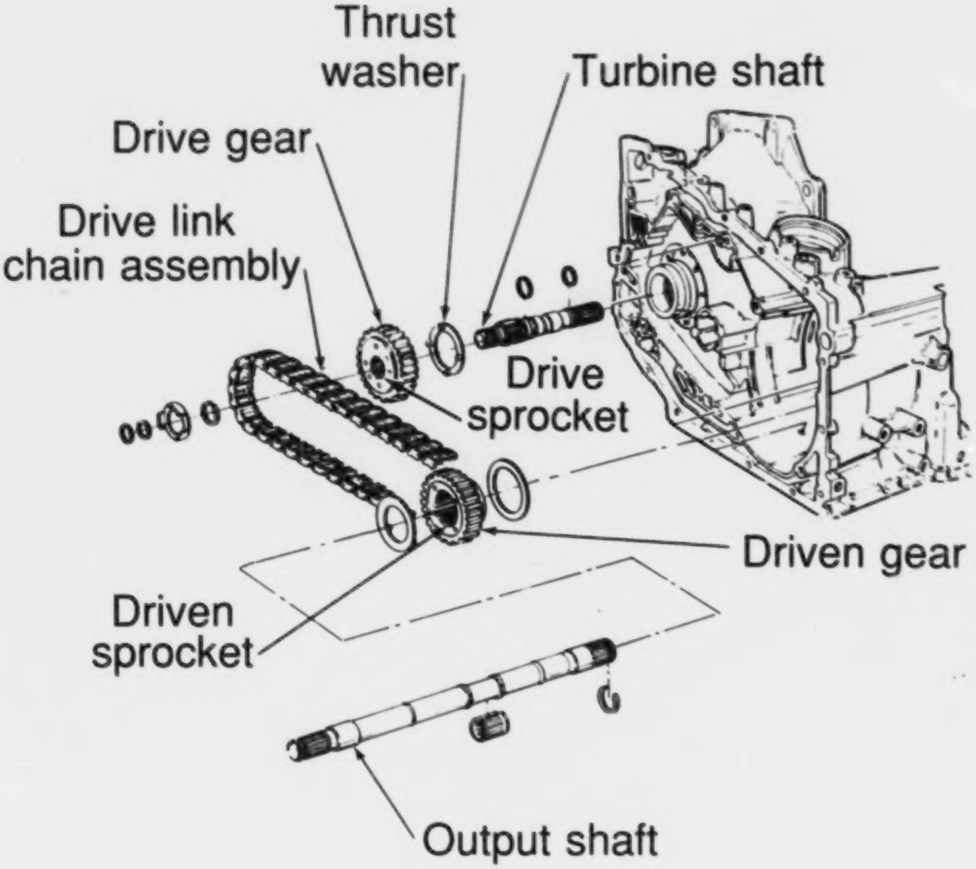
Drive Link Assembly



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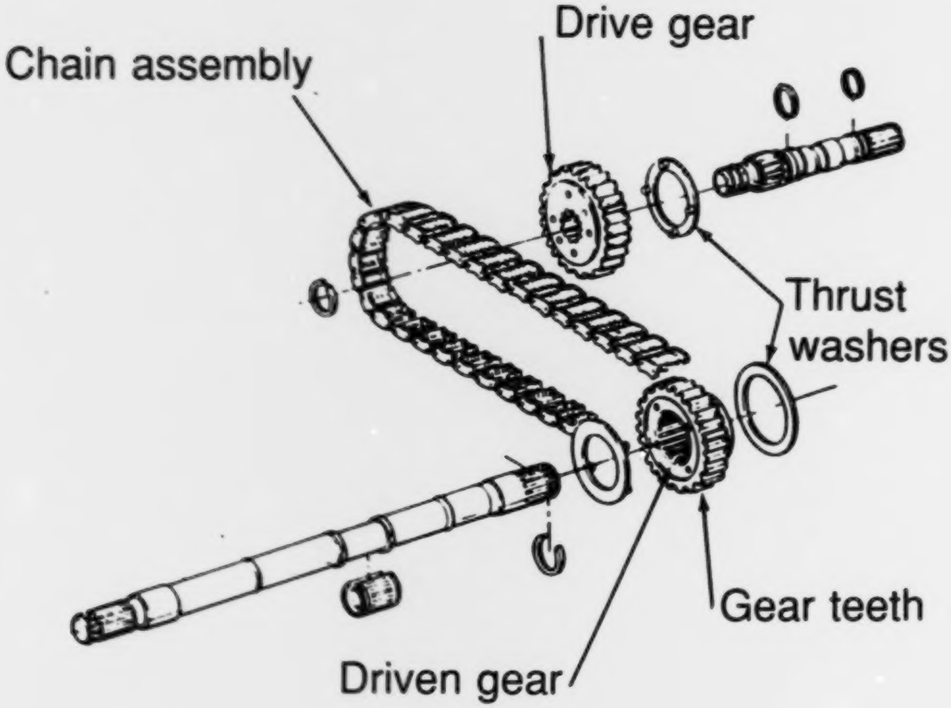
Drive Link Assembly Wear Points



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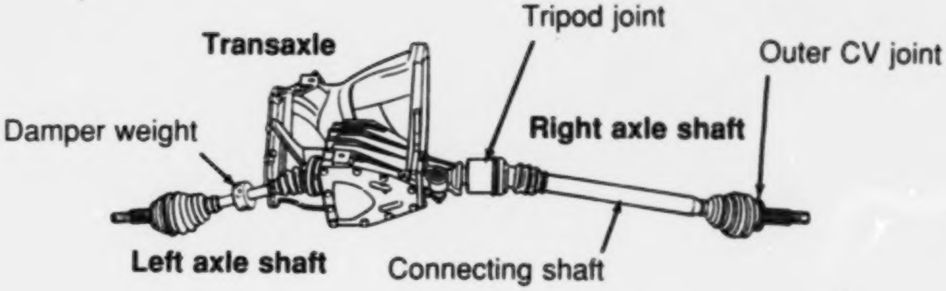
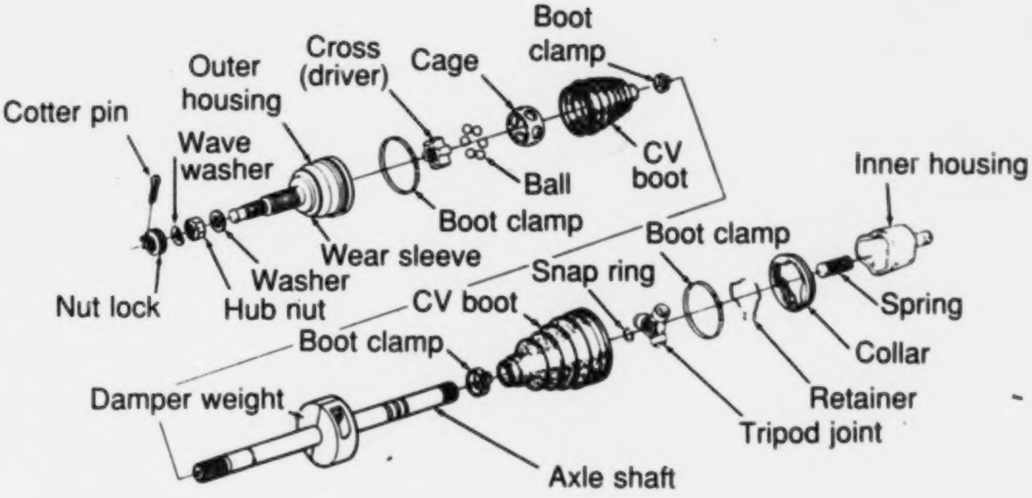
Axle Shaft Assembly





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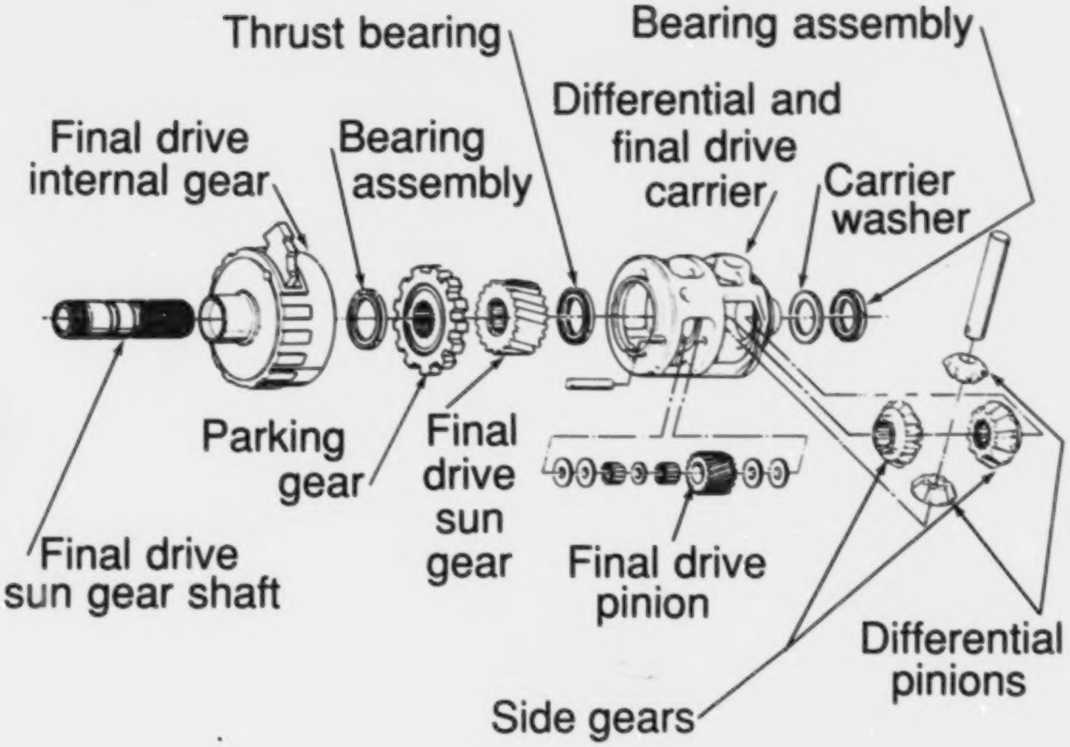
Final Drive and Differential Assembly



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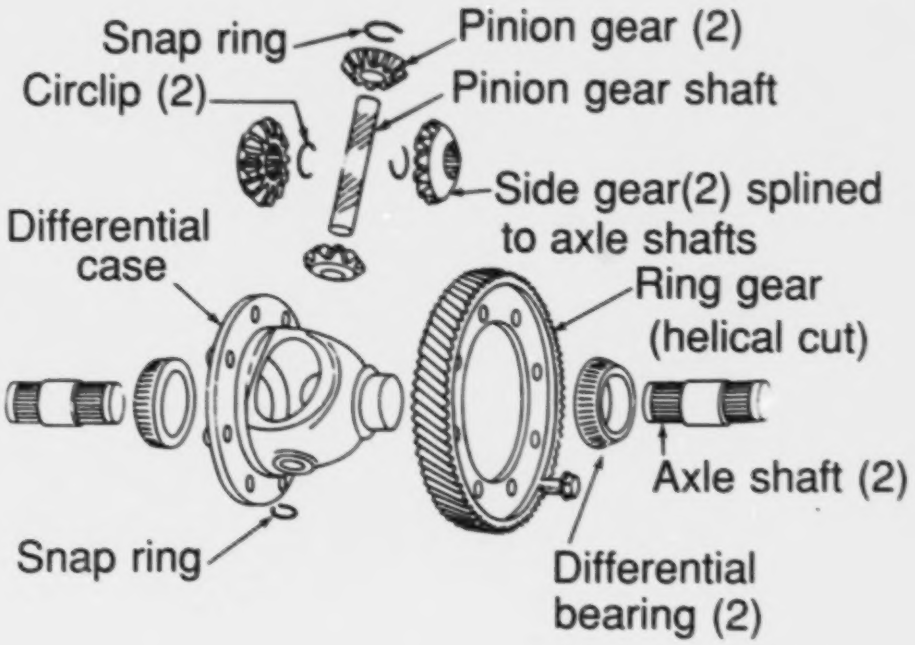
Helical-Cut Final Drive Gearset



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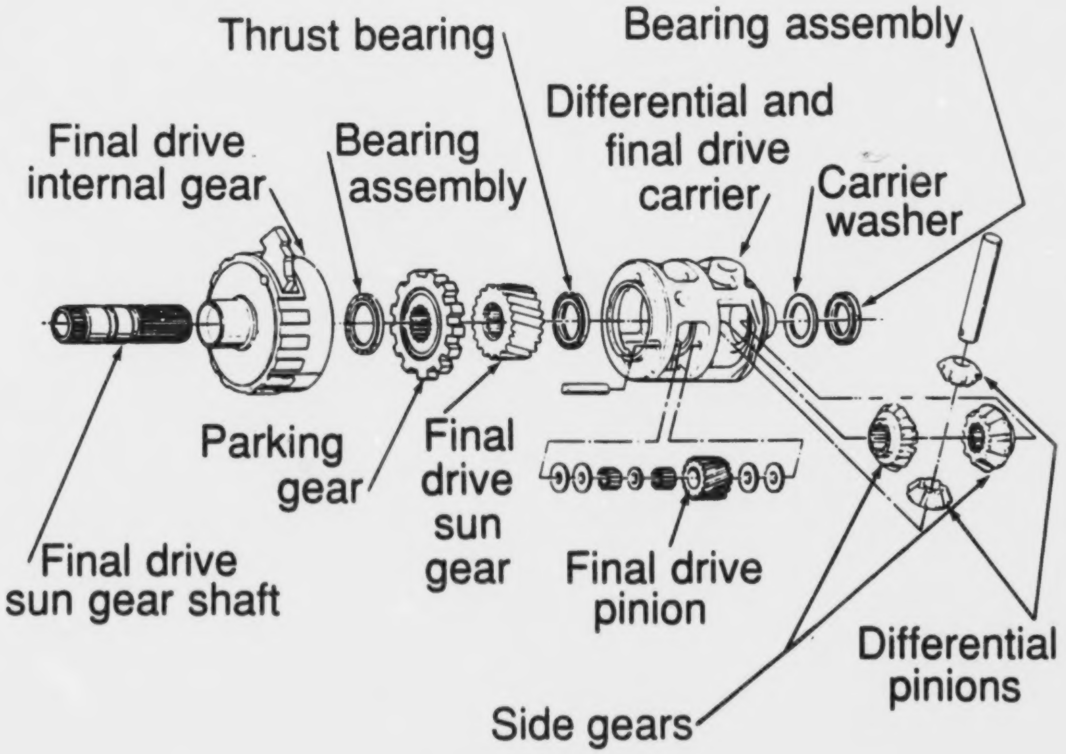
Final Drive Planetary Gearset and Differential Assembly



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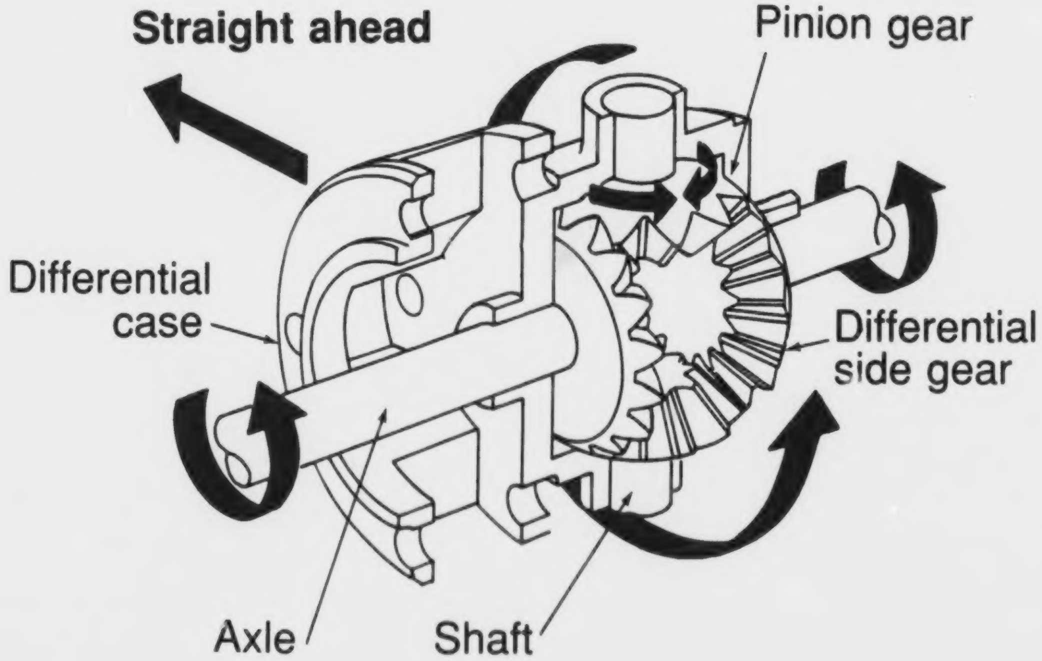
Bevel Gear Final Drive



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WRITTEN TEST

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Name ______________________ Score __________

OBJECTIVE 1

Answer questions about the characteristics of a front-wheel drive automatic transmission/transaxle. Write a short answer to each question.

1. How is the transaxle connected to the front wheels?

2. What two components are involved in the transfer of torque, allowing the FWD vehicle to be pulled?

3. What must happen to drive the wheels?

4. What characteristics of FWD design prevent interior room from being sacrificed?

5. In what two ways does FWD design compare favorably with rear wheel drive vehicles?

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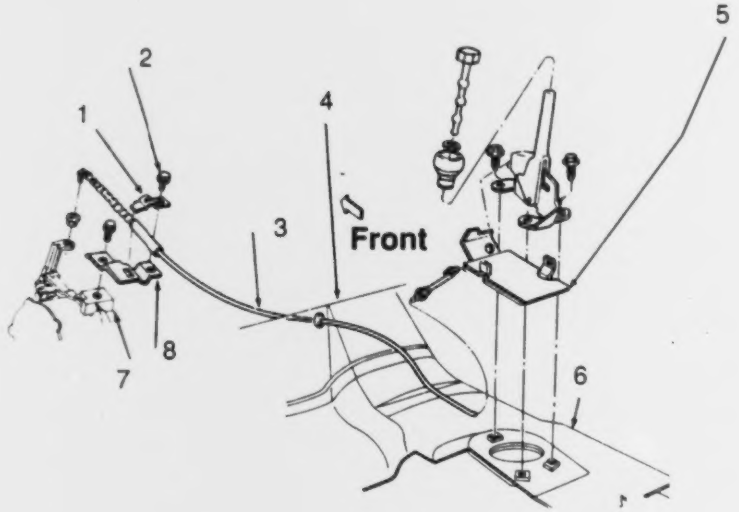
OBJECTIVE 2

Label the parts of a typical gearshift linkage on a front-wheel drive transaxle. Write the correct names after the corresponding numbers below the illustration.



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1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________

OBJECTIVE 3

Describe the functions of various types of automatic transaxle linkages and controls.

1. throttle linkage ____

   ____

2. manual shift linkage ____

   ____

May be photocopied for student use.

3. kickdown linkage ____________________

____

4. neutral safety switch ____________________

____

5. vacuum regulator valve ____________________

____

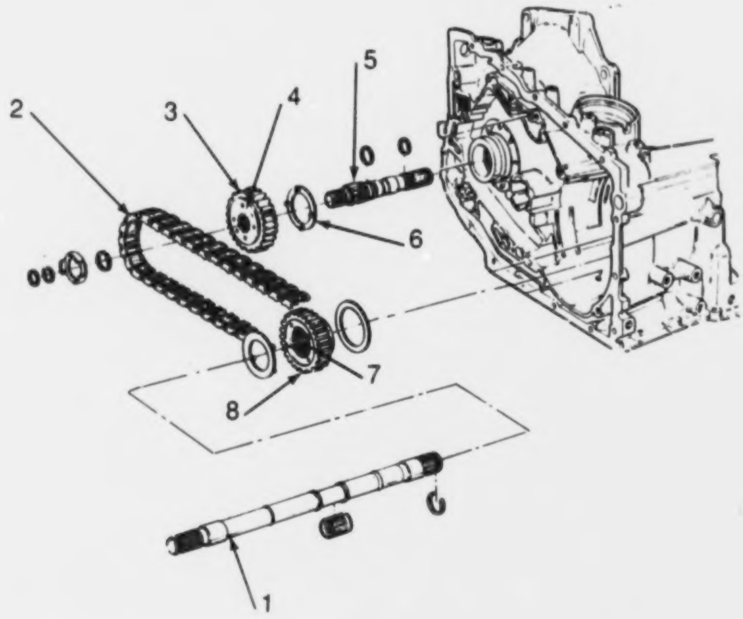
OBJECTIVE 4

State the function of the transaxle drive link assembly.

____

OBJECTIVE 5

Label the parts of a transaxle drive link assembly. Write the correct names after the corresponding numbers below the illustration.



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1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

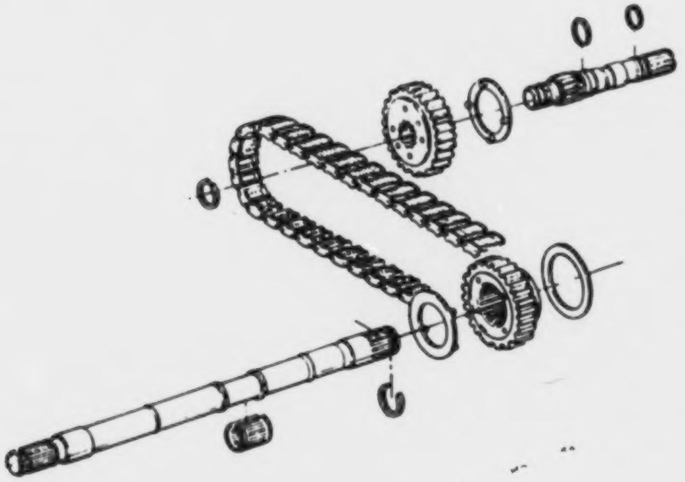
6. ____________________

7. ____________________

8. ____________________

OBJECTIVE 6

Identify wear points of a transaxle drive link assembly. Name the common transaxle drive link wear points and draw an arrow to each.



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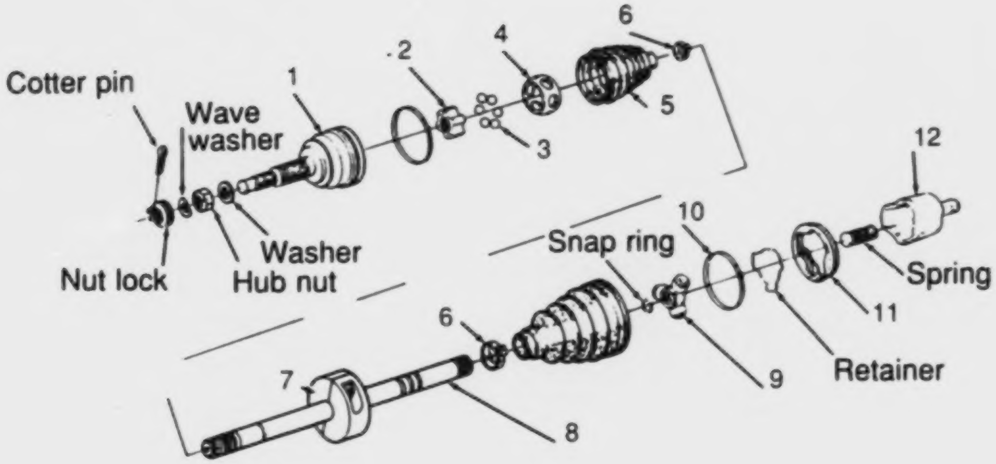
OBJECTIVE 7 **Label the parts of a typical FWD axle shaft assembly.** Write the correct names after the corresponding numbers below the illustration.



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1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

8. ____________________

9. ____________________

10. ____________________

11. ____________________

12. ____________________

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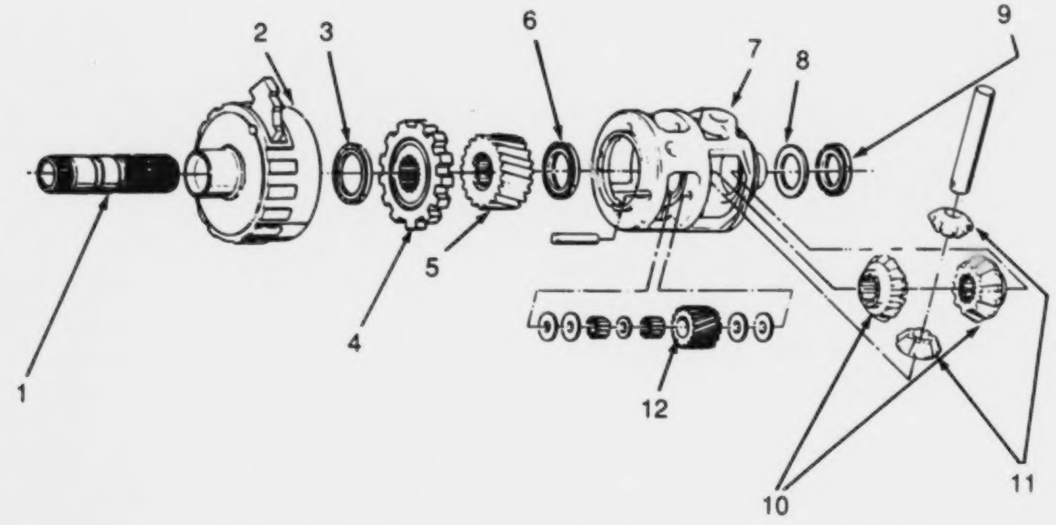
OBJECTIVE 8 **Label the parts of a typical final drive and differential assembly.** Write the correct names after the corresponding numbers below the illustration.



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1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

8. ____________________

9. ____________________

10. ____________________

11. ____________________

12. ____________________

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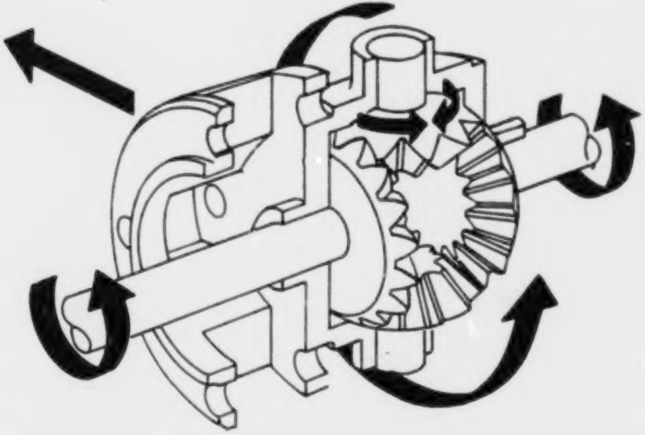
OBJECTIVE 9

Identify final drive arrangements and gear types. Write the correct name in the space below each illustration.



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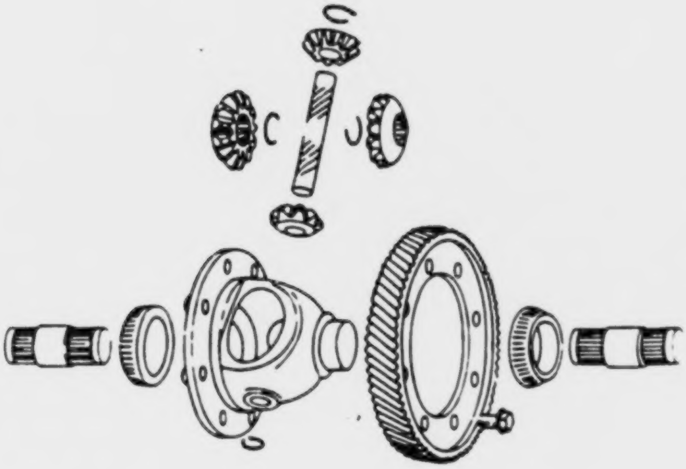
1. ______________________________



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2. ______________________________

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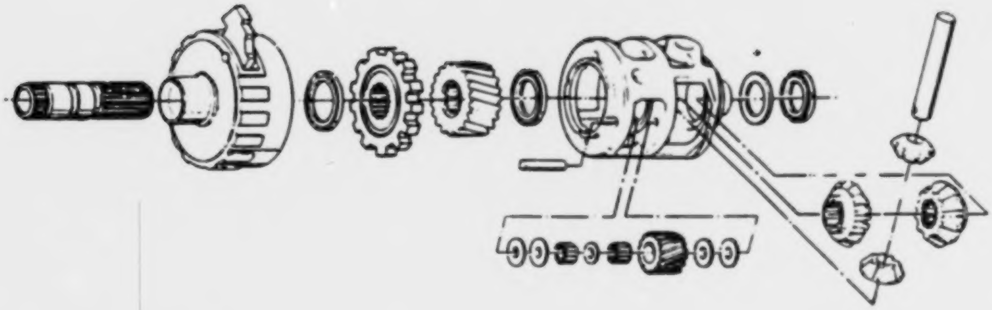

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3. ______________________________

OBJECTIVES 10-15

Evaluated on Job Sheets 1-6.

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LAP
SHEET

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Name ______________________________

Check the blank as you complete each step.

1. Take ____ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

2. Read ____ the introduction, unit objective, and specific objectives.

3. Do ____ the focus assignments.

4. Stop ____ and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.

5. Study ____ the Information Sheet, Objective 1. Think about the importance of following the steps in order.

Optional: Study ____ sample oil circuit diagrams for various automatic transmissions. Note the colors, abbreviations, and symbols used to simplify complex relationships. Practice interpreting the various oil circuit diagrams.

6. Do ____ Assignment Sheet 1.

7. Stop ____ and have your instructor evaluate your work from the Assignment Sheet. After your work has been evaluated, follow your instructor's recommendations.

Optional: Study ____ sample application/range reference charts. Look for sample shift speed charts and clutch and band application charts. Practice interpreting the various charts.

8. Do ____ Assignment Sheet 2.

May be photocopied for student use.

9. **Stop** _____ and have your instructor evaluate your work from the Assignment Sheet. After your work has been evaluated, follow your instructor's recommendations.

Optional:
Study _____ sample troubleshooting charts for various automatic transmissions.

10. **Do** _____ Assignment Sheet 3.

11. **Stop** _____ and have your instructor evaluate your work from the Assignment Sheet. After your work has been evaluated, follow your instructor's recommendations.

Optional:
Study _____ sample electrical circuit test charts.

12. **Do** _____ Assignment Sheet 4.

13. **Stop** _____ and have your instructor evaluate your work from the Assignment Sheet. After your work has been evaluated, follow your instructor's recommendations.

14. **Study** _____ the Information Sheet, Objective 6. Describe for yourself the general symptoms revealed by each of the transmission system tests.

15. **Study** _____ the Information Sheet, Objective 7.

16. **Locate** _____ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

17. **Ask** _____ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

18. **Practice** _____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

19. **Stop** _____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

20. **Locate** _____ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

May be photocopied for student use.

21. **Ask** _____ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

22. **Practice** _____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

23. **Stop** _____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

24. **Locate** _____ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

25. **Ask** _____ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

26. **Practice** _____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

27. **Stop** _____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

28. **Locate** _____ the procedure(s) for Job Sheet 4 in the service manual for the make and model vehicle you are servicing.

29. **Ask** _____ your instructor to demonstrate the guidelines and procedures in Job Sheet 4. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

30. **Practice** _____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

31. **Stop** _____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

32. **Take** _____ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

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WRITTEN TEST

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Name ______________________________ Score __________

OBJECTIVE 1

List the basic steps in automatic transmission diagnosis.

Step 1: ______________________________

____

Step 2: ______________________________

____

Step 3: ______________________________

____

Step 4: ______________________________

____

Step 5: ______________________________

____

OBJECTIVE 2 Evaluated on Assignment Sheet 1.

OBJECTIVE 3 Evaluated on Assignment Sheet 2.

OBJECTIVE 4 Evaluated on Assignment Sheet 3.

OBJECTIVE 5 Evaluated on Assignment Sheet 4.

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OBJECTIVE 6

Distinguish among the purposes of stall tests, road tests, control pressure tests, and lock-up converter system tests. Write the applicable test name before each purpose.

____________________ 1. Revealing possible problems in the oil pump, governor, and throttle circuits

____________________ 2. Verifying customer complaint(s)

____________________ 3. Determining whether the clutches and bands are slipping

____________________ 4. Diagnosing electrical problems

____________________ 5. Determining whether oil and/or vacuum pressures in the various transmission circuits are normal

____________________ 6. Checking stator operation in the torque converter

____________________ 7. Checking torque converter clutch lock-up application in the TCC system

____________________ 8. Determining correct shift speeds/ranges for the transmission being tested

OBJECTIVE 7

List safety guidelines for performing stall tests, road tests, control pressure tests, and lock-up converter system tests.

1. List four stall test safety guidelines.

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

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2. List four road test safety guidelines.

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

3. List two control pressure test guidelines.

- ____
  ____
- ____
  ____

4. List a lock-up converter system test guideline.

- ____
  ____

OBJECTIVE 8	Evaluated on Job Sheet 1.
OBJECTIVE 9	Evaluated on Job Sheet 2.
OBJECTIVE 10	Evaluated on Job Sheet 3.
OBJECTIVE 11	Evaluated on Job Sheet 4.

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LAP SHEET

TESTING RELATED ELECTRONIC COMPONENTS

9

Name ____________________

Check the blank as you complete each step.

1. **Take** ____ the pretest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

2. **Read** ____ the introduction, unit objective, and specific objectives.

3. **Do** ____ the focus assignments.

4. **Stop** ____ and have your instructor evaluate your work from the focus assignment. After your work has been evaluated, follow your instructor's recommendations.

5. **Study** ____ the Information Sheet, Objective 1.

Optional: Watch ____ the videos *The Automotive Computer: Explaining the Black Box* and *The Automotive Computer: The Computer in Action.*

Optional: Complete ____ *Automotive Mechanics GM Computer Command Control* software lessons and quizzes.

Optional: Locate ____ electronic control system components on a vehicle.

6. **Study** ____ the Information Sheet, Objective 2.

Optional: Locate ____ the various sensors and switches on several vehicles of different makes and models.

7. **Study** ____ the Information Sheet, Objective 3. Review the "Words You Should Know."

May be photocopied for student use.

Optional: Ask ____ your instructor for examples of each tool listed. Ask your instructor to demonstrate how to use each tool. Ask about any variations in manufacturer-specific tools.

8. Study ____ the Information Sheet, Objectives 4-7.

Optional: Make ____ a pocket reference of Ohm's Law formulas.

9. Study ____ the Information Sheet, Objectives 8-11.

Optional: Make ____ a pocket reference of formulas from Ohm's Law for power.

10. Study ____ the Information Sheet, Objective 12.

11. Ask ____ your instructor to show you examples of the various switches and sensors.

Optional: Locate ____ the various sensors and switches on a rear-wheel drive vehicle.

12. Study ____ the Information Sheet, Objectives 13 and 14.

13. Do ____ Assignment Sheet 1.

14. Stop ____ and have your instructor evaluate your work from the Assignment Sheet. After your work has been evaluated, follow your instructor's recommendations.

15. Locate ____ the procedure(s) for Job Sheet 1 in the service manual for the make and model vehicle you are servicing.

16. Ask ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 1. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

17. Practice ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

18. Stop ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

May be photocopied for student use.

19. **Locate** ____ the procedure(s) for Job Sheet 2 in the service manual for the make and model vehicle you are servicing.

20. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 2. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

21. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

22. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

23. **Locate** ____ the procedure(s) for Job Sheet 3 in the service manual for the make and model vehicle you are servicing.

24. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 3. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

25. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

26. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

27. **Locate** ____ the procedure(s) for Job Sheet 4 in the service manual for the make and model vehicle you are servicing.

28. **Ask** ____ your instructor to demonstrate the guidelines and procedures in Job Sheet 4. Use the Job Sheet to follow along. Pay careful attention to any guidelines, cautions, and warnings.

29. **Practice** ____ the procedures demonstrated by your instructor. Use the Job Sheet as a guide. Notify your instructor when you are ready to perform the procedures for evaluation.

30. **Stop** ____ and have your instructor evaluate your work from the Job Sheet. After your work has been evaluated, follow your instructor's recommendations.

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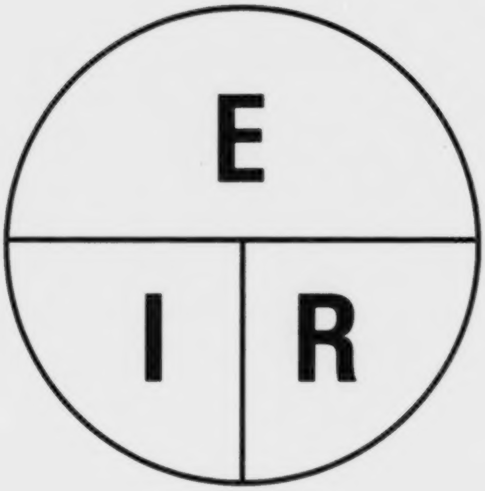
31. Take _____ the posttest provided by your instructor. Have your instructor evaluate your completed test. After your test has been evaluated, follow your instructor's recommendations.

May be photocopied for student use.

TM 1

Ohm's Law in Wheel Expression



E = Volts

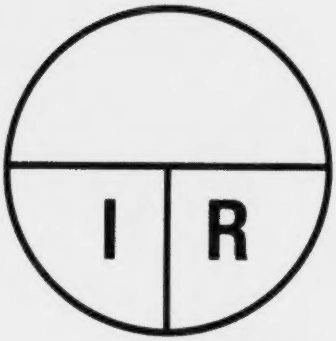
I = Amps

R = Ohms

May be photocopied for student use.

Formula for Voltage

E =



or E = I x R

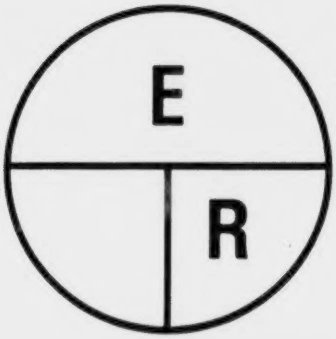
or Volts = Amps x Ohms

May be photocopied for student use.

TM 3

Formula for Amperage

I =



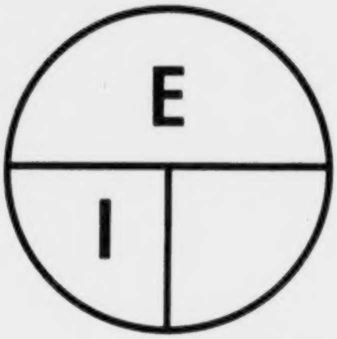
or I = E/R

or Amps = Volts ÷ Ohms

May be photocopied for student use.

Formula for Resistance

R =



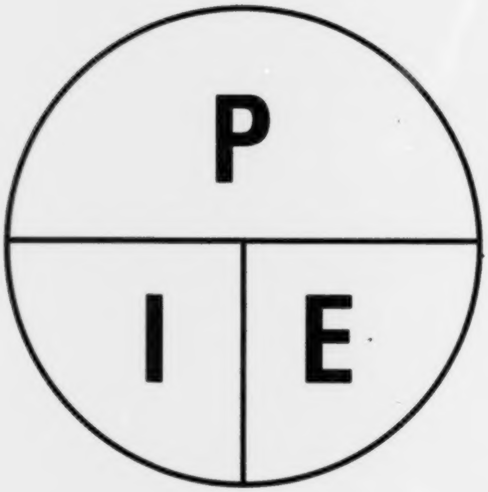
or $R = E/I$

or Ohms = Volts ÷ Amps

May be photocopied for student use.

TM 5

Ohm's Law for Power in Wheel Expression



P = Watts

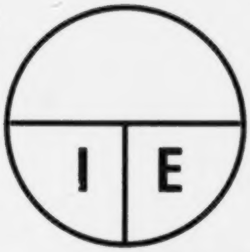
I = Amps

E = Volts

May be photocopied for student use.

Formula for Wattage

P =



or P = I x E

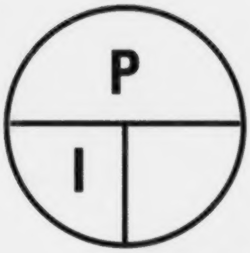
or Watts = Amps x Volts

May be photocopied for student use.

TM 7

Formula for Voltage

$E =$



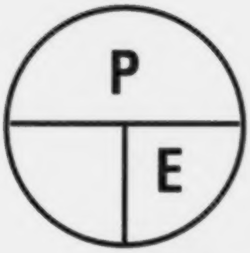
or $E = P/I$

or Volts = Watts ÷ Amps

May be photocopied for student use.

Formula for Amperage

I =



or I = P/E

or Amps = Watts ÷ Volts

May be photocopied for student use.

WRITTEN TEST

TESTING RELATED ELECTRONIC COMPONENTS

9

Name ______________________ Score ______________

OBJECTIVE 1

Match computer control system components with their functions. Write the correct letters in the blanks.

A. sensor
B. electronic control unit (ECU)
C. transmission/transaxle control unit (TCU)
D. actuator
E. self-diagnostic system
F. trouble code
G. memory
H. diagnostic link (electrical connector)
I. solenoid
J. switch
K. engine control module (ECM)
L. vehicle-speed sensor (VSS)

_____1. electronically-controlled, electrically-operated output device used to operate some units (execute a mechanical action)

_____2. converts physical symptoms to electrical input signals; used to detect a change in a vehicle system and to emit a suitable signal to the ECU

_____3. stores data until it is needed for processing operations

_____4. checks the computer control system at the factory and provides connecting points (multi-pin terminals) for test equipment in the field

_____5. converts electrical output signals into physical (mechanical) action

_____6. detects an abnormal operating condition and places a warning signal (trouble code) into the unit's memory system

_____7. activates warning display

May be photocopied for student use.

_____8. controls the operation of the shift solenoids and the TCC control solenoid by switching them on and off at the correct time; often works with ECU to also control fuel metering and ignition timing and other functions depending on transmission/transaxle model

_____9. mechanically or hydraulically operated input device that delivers component data to the computer

_____10. main computer that processes input signals and supplies output data; group of electronic components wired into a unified circuit to produce specific electrical signals in response to external sensor outputs; the "brain" of a vehicle computer system

_____11. controls the torque converter clutch (TCC)

_____12. produces an electrical signal sent to the ECU/ECM to indicate vehicle speed

OBJECTIVE 2 **Describe basic operational stages of a computer control system.**

Stage 1: input ____

____

____

Stage 2: processing ____

____

____

Stage 3: output ____

____

____

OBJECTIVE 3 **Describe the functions of various electrical/electronic test tools.**

1. Jumper wires ____

____

May be photocopied for student use.

2. Test light ______________________________

____

3. Multimeter (VOM) ______________________________

____

4. Voltmeter ______________________________

____

5. Ammeter ______________________________

____

6. Ohmmeter ______________________________

____

7. Scan tool ______________________________

____

8. Diagnostic analyzer ______________________________

____

9. Breakout box test chart ______________________________

____

OBJECTIVE 4 **State Ohm's Law.**

Ohm's Law = ______________________________

____

May be photocopied for student use.

OBJECTIVE 5 **Draw Ohm's Law in wheel expression.**

OBJECTIVE 6 **List uses of Ohm's Law.**

1. ______________________________

2. ______________________________

3. ______________________________

OBJECTIVE 7 **State the unit of measure formulas from Ohm's Law.**

1. Formula for voltage ________________________
2. Formula for amperage ________________________
3. Formula for resistance ________________________

OBJECTIVE 8 **State Ohm's Law for power.**

Ohm's Law for power = ________________________

____

May be photocopied for student use.

OBJECTIVE 9 **Draw Ohm's Law for power in wheel expression.**

OBJECTIVE 10 **List uses of Ohm's Law for power.**

1. ____________________

2. ____________________

3. ____________________

OBJECTIVE 11 **State the unit of measure formulas from Ohm's Law for power.**

1. Formula for wattage ____________________

2. Formula for voltage ____________________

3. Formula for amperage ____________________

OBJECTIVE 12 **Describe the purposes of sensors and switches used to send the electronic control unit information for torque converter clutch operation.**

1. shift solenoids ____________________

____

2. throttle position sensor ____________________

____

3. vacuum switches (3) ____________________

____

May be photocopied for student use.

4. shift lever switch ______________________________

____

5. vehicle-speed sensor (VSS) ______________________________

____

6. coolant temperature sensor ______________________________

____

OBJECTIVE 13

List advantages of computer control of torque converter. List five advantages.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

OBJECTIVE 14

Explain how a solenoid operates a torque converter clutch.

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

____

May be photocopied for student use.

6. ____

____

7. ____

____

8. ____

____

OBJECTIVE 15 Evaluated on Assignment Sheet 1.

OBJECTIVES 16-19 Evaluated on Job Sheets 1-4.

May be photocopied for student use.

Automatic Transmission/ Transaxle Specialist

Student Workbook

Developed by the
Curriculum and Instructional Materials Center
for the Division of Trade and Industrial Education
Oklahoma Department of Vocational and Technical Education

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Printed in the United States of America by the
Oklahoma Department of Vocational and Technical Education
Stillwater, Oklahoma 74074-4364

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TABLE OF CONTENTS

One set per unit of Objective Sheets, Information Sheets, Assignment Sheets, and Job Sheets for the following units:

UNIT 1
Introduction to Automatic Transmissions and Transaxles 1-1

UNIT 2
Servicing Hydraulic System Components 2-1

UNIT 3
Servicing Rear-Wheel Drive Transmissions 3-1

UNIT 4
Servicing Torque Converter and Oil Pump 4-1

UNIT 5
Servicing Gear Train/Gearsets 5-1

UNIT 6
Servicing Friction Units and Cooler 6-1

UNIT 7
Servicing Front-Wheel Drive Transaxles 7-1

UNIT 8
Diagnosing General Automatic Transmission/Transaxle Problems 8-1

UNIT 9
Testing Related Electronic Components 9-1

OBJECTIVE SHEET

INTRODUCTION TO AUTOMATIC TRANSMISSIONS AND TRANSAXLES

1

INTRODUCTION

The automotive transmission provides the various gear ratios for forward and reverse vehicle motion. Before the 1940s, every vehicle used a clutch and manual transmission. The first automatic transmission was the Hydra-Matic Drive introduced on the 1940 Oldsmobile. By the 1960s, most automobiles made in the United States had an automatic transmission option. Today, over 80 percent of the automobiles sold in North America are equipped with automatic transmissions.

Both manual and automatic transmissions function to provide the vehicle with the needed gear ratios for movement. The *manual* transmission requires the driver to manually perform each shift by depressing the clutch and moving the shift lever to the gear selected. The *automatic* transmission automatically selects the proper upshifts and downshifts. In the past, several manufacturers offered *semiautomatic* transmissions. These transmissions tried to incorporate the best features of both manual and automatic transmissions. The driver had to perform each of the upshifts and downshifts but did not have to manually operate a clutch pedal.

While there have been numerous types of automatic transmissions of various construction and design, the general operating principles for automatic transmissions are the same. Most automatic transmissions use a torque converter (or fluid coupling) to transmit torque to one or more planetary gearsets. These gearsets are controlled by servos and clutches that are actuated by oil pressure. The oil pressure is controlled by various devices.

Today, most automatic transmissions are computer controlled. Many common components that used to be used to control the transmission's pressure and shifting have been replaced by solenoids and pulse generators. However, no matter how old or new the transmission design, the internal workings, the clutches, bands, sprags, and torque converters operate using the same *principles* of operation. Therefore it is necessary to begin understanding the principles of automatic transmissions by starting with the basics.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS

PREREADING:	Read the introductory material to automatic transmissions/transaxles in your textbook.
WRITING:	Research and write a brief history (one page) of the automatic transmission.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Assignment Sheet and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Correct false statements about hydraulic theory.
2. Solve problems involving Pascal's Law. (Assignment Sheet)
3. Explain the functions of basic components common to simple hydraulic systems.
4. Explain how a torque converter functions as both a fluid coupling and a torque multiplier.
5. Label the basic components of an automatic transmission and an automatic transaxle.
6. List types of automatic transmissions/transaxles.
7. List the advantages and disadvantages of conventional automatic transmissions/transaxles over manual transmissions.

8. Distinguish between symptoms that require simple service and those that require overhaul or repair.

9. State reasons for identifying a transmission before servicing.

10. State ways of identifying an automatic transmission before servicing.

11. Answer questions about automatic transmission fluid.

12. State the functions of automatic transmission fluid.

13. List the effects of too little or too much automatic transmission fluid.

14. Explain the functions of given friction devices.

15. Match automatic transmission gear indicators/gears with their functions.

INFORMATION SHEET

INTRODUCTION TO AUTOMATIC TRANSMISSIONS AND TRANSAXLES

1

OBJECTIVE 1

Correct false statements about hydraulic theory.

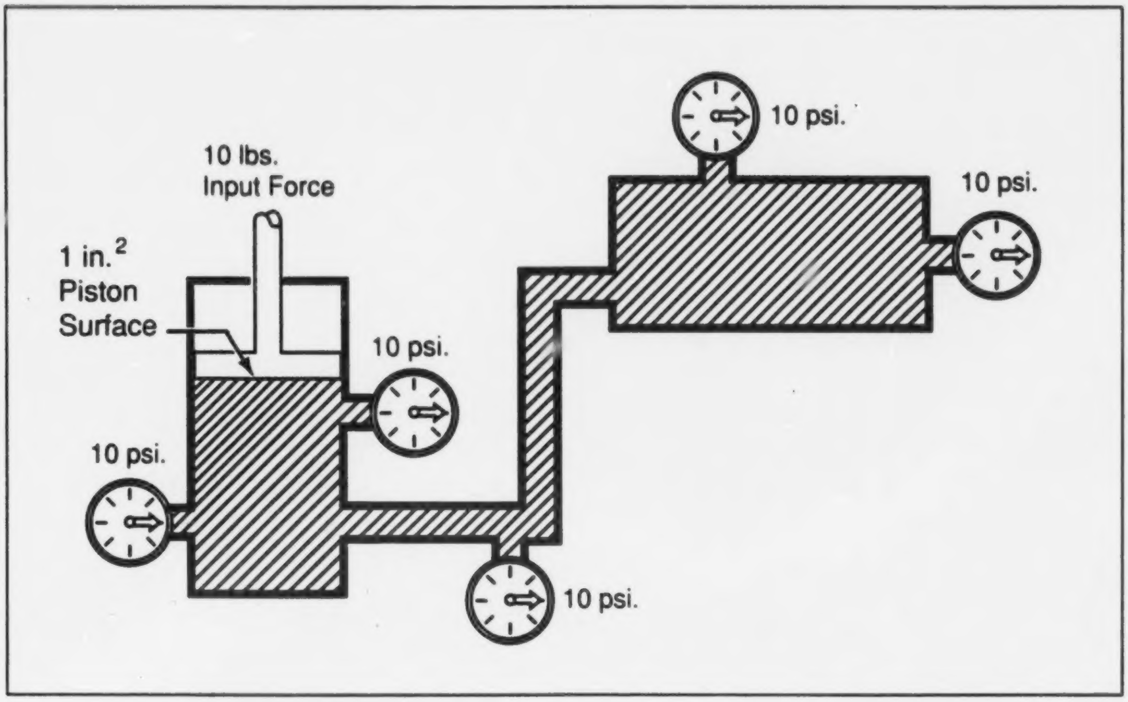
Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

WORDS YOU SHOULD KNOW	
hydraulics	the use of liquid to transmit power (motion or force)
compressed	squeezed into a smaller volume
force	push or pull measured in units of weight, usually pounds; Output Force = System Pressure × Output Piston Area
pressure	amount of force (psi or kPa) pushing on a specific area; System Pressure = Input Force ÷ Input Piston Area
energy	force and motion; the ability to do work
power	the rate at which work is done
work	the result of force that changes speed or direction of motion

- **Pascal's Law**
    - ☐ Liquids cannot be compressed.
    - ☐ Liquids take the shape of whatever container they are in.
    - ☐ Liquids transmit pressure equally in all directions; therefore, hydraulic pressure acts with equal force on all surfaces. (Figure 1)

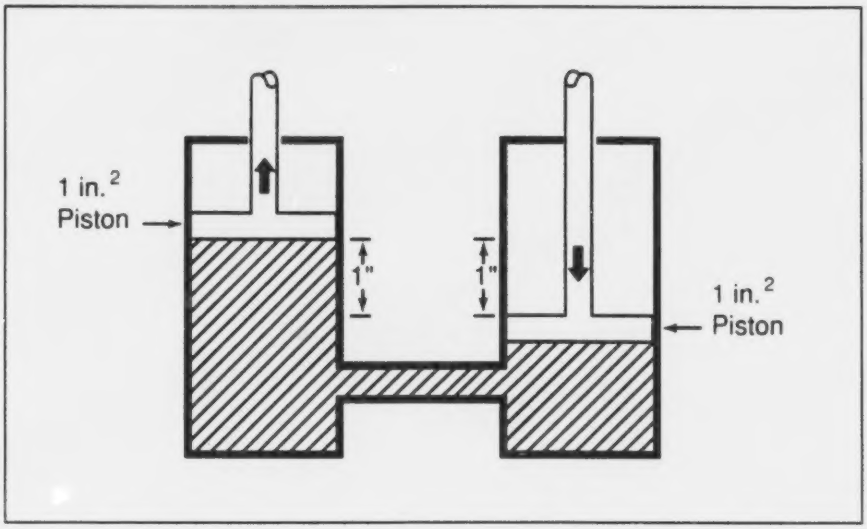
FIGURE 1



- **Mechanical advantage**
  - ☐ The force applied is directly related to the results obtained.
  - ☐ Once a container is full of liquid, any added force becomes fluid pressure.
  - ☐ A hydraulic system can only transmit energy that is put into it; it cannot create energy.
- **Motion**
  - ☐ Motion and force can be transmitted without change—from one cylinder to another through tubing.

    EXAMPLE: If two identical cylinders—each having a piston with the same surface area (1 square inch)—are connected with a tube, when one piston is forced down 1 inch, the other will rise 1 inch. (Figure 2)

FIGURE 2



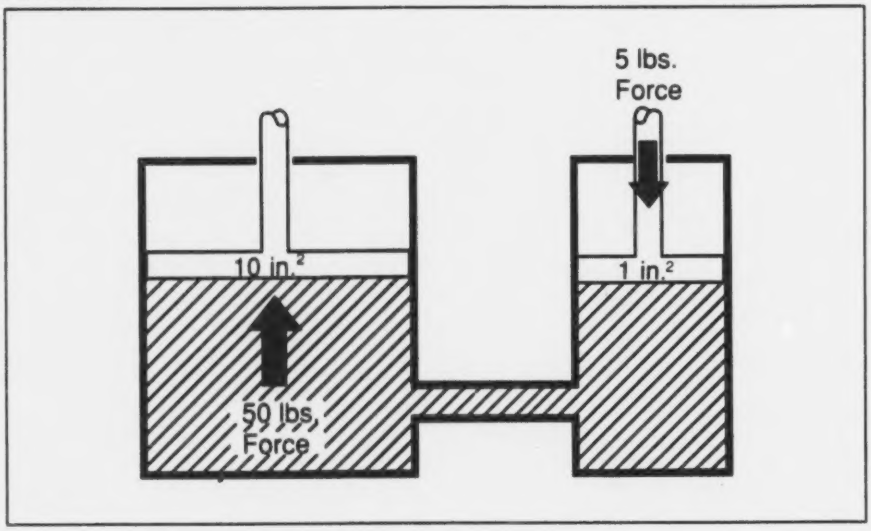
- ☐ It is possible to change motion to force and vice versa.
- ☐ When force is increased, motion is decreased; when force is decreased, motion is increased.

  EXAMPLES: 1) If the output and input piston areas are equal, input and output motion are also equal. 2) If the output piston area is doubled, output force is doubled, but output motion is halved. 3) If the output piston area is halved, output force is halved, but output motion is doubled.

- **Surface area**
  - ☐ Motion or force can be increased (multiplied) by using input or output pistons with different surface areas.

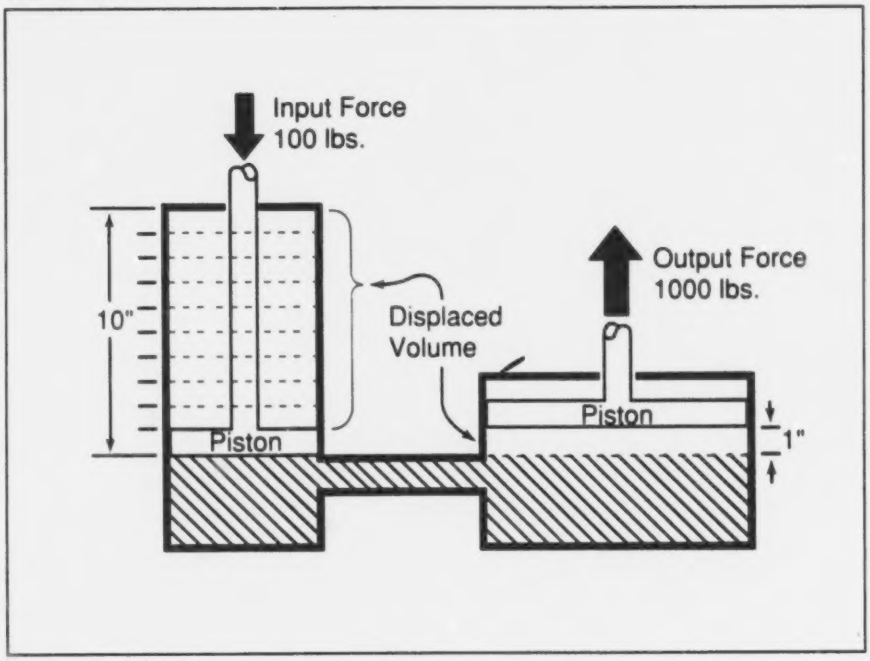
    EXAMPLE: Assume that a hydraulic system contains two connected pistons, one with a surface area of 1 square inch, and one with a surface area of 10 square inches. When a 5-pound force is applied to the 1-square-inch piston, liquid in the system transmits 5 pounds of pressure to *every square inch* in the system, thus pushing the larger piston with a force of 50 pounds. (Figure 3)

FIGURE 3



- ☐ The volume of fluid required to stroke a piston is determined by the diameter of the piston and the length of the stroke. (Figure 4)

FIGURE 4



☑ **NOTE:** Because the output piston is 10 times larger than the input piston, the input piston must travel 10 times farther to supply the liquid.

OBJECTIVE 2

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Complete the Assignment Sheet.

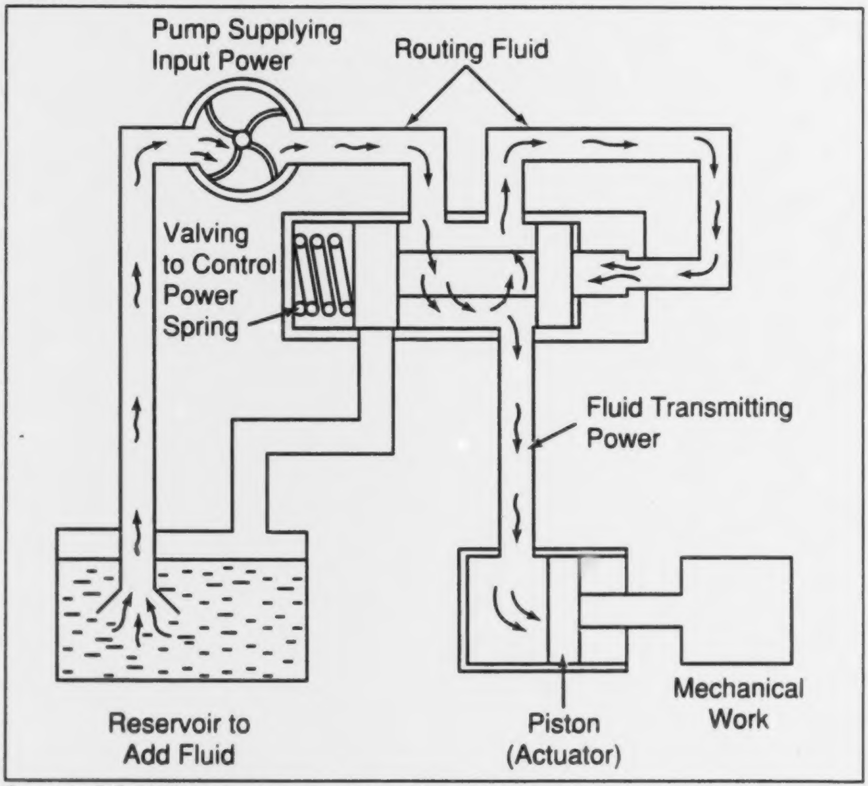
OBJECTIVE 3

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Explain the functions of basic components common to simple hydraulic systems.

FIGURE 5



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- **engine- or motor-driven pump** — supplies input power
- **fluid** — transmits power
- **reservoir** — holds the fluid
- **filter** — prevents impurities from contaminating the fluid

- **tubes or cylinders** — route the fluid
- **valves** — control the power
- **actuators** — provide system output

OBJECTIVE 4

Optional Activities/
Resources in
Instructor's Guide

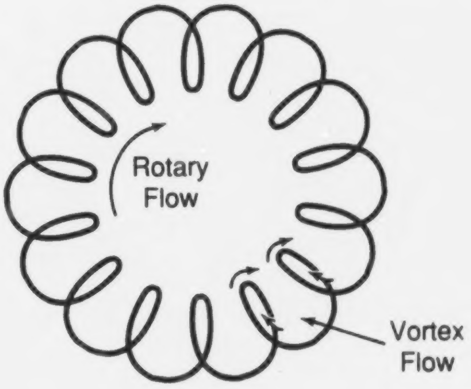
Required Activities/
Resources in
Instructor's Guide

Explain how a torque converter functions as both a fluid coupling and a torque multiplier.

WORDS YOU SHOULD KNOW

inertia	force that tends to keep stationary objects from moving and to keep moving objects in motion
rotary motion	continual motion in a circular direction such as performed by the crankshaft (See Figure 6 below.)
splined	joined when metal splines (lands) between one part slide into grooves between spline on another part
torque	turning or twisting force
torus	one of two half-doughnut-shaped fluid-coupling rotating members
vortex flow	whirling motion of oil in the torque converter at a right angle to the impeller rotation (Figure 6)

FIGURE 6



- **Fluid coupling**

  - ☐ A simple fluid coupling consists of an impeller (driving component) and a turbine (driven component).

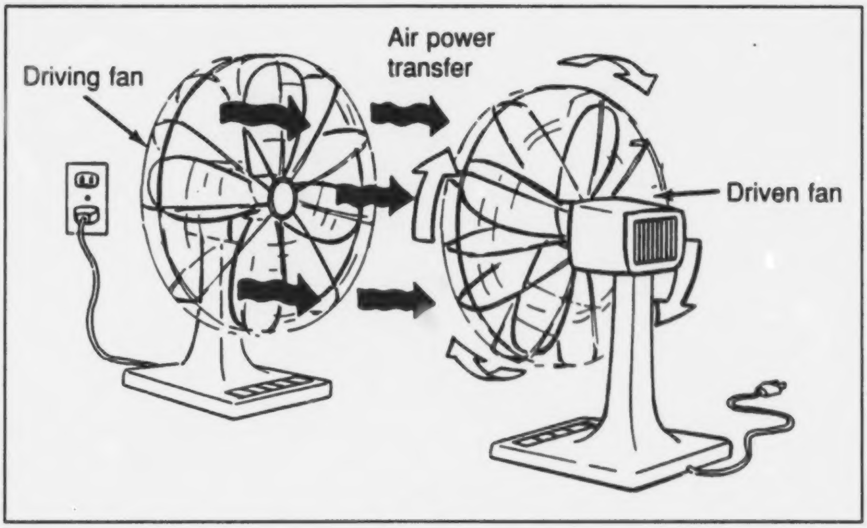
  - ☐ The impeller is connected to the engine flywheel through the fluid-coupling metal housing.

  - ☐ The turbine is placed closely in front of the impeller, separated by a small space.

  - ☐ Power transfer occurs when the impeller throws oil against the turbine, causing the turbine to turn.

    ☑ **NOTE:** The impeller and turbine resemble two fans that face each other at close range (Figure 7). When one fan is plugged in, the air stirred by its driving blades causes the other (driven) fan to spin. Because the fans are not in an enclosed area, however, power transfer is not very efficient.

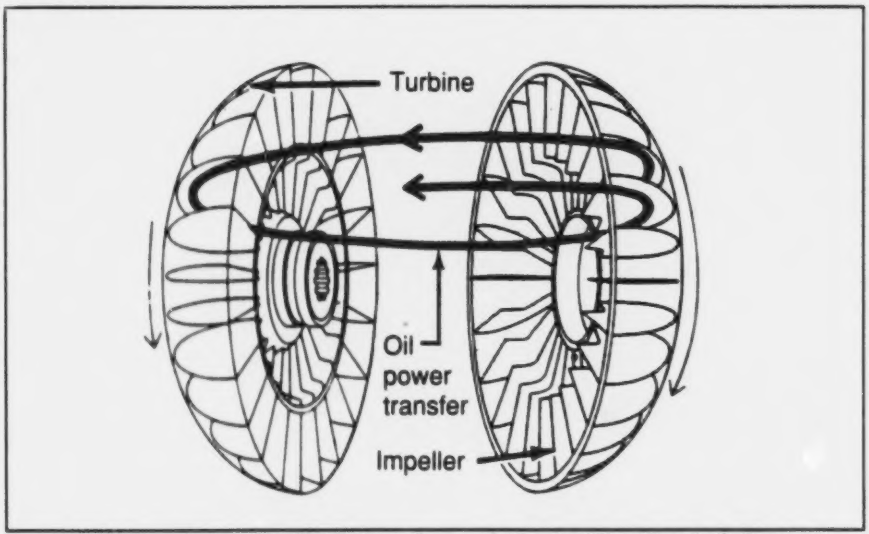
FIGURE 7



  - ☐ While air is the medium of power transfer with the fans, oil is the medium of power transfer with a fluid coupling.

    ☑ **NOTE:** Also, because the driving and driven components of the converter are mounted very close together in an enclosed space, power transfer is very efficient. (Figure 8)

FIGURE 8



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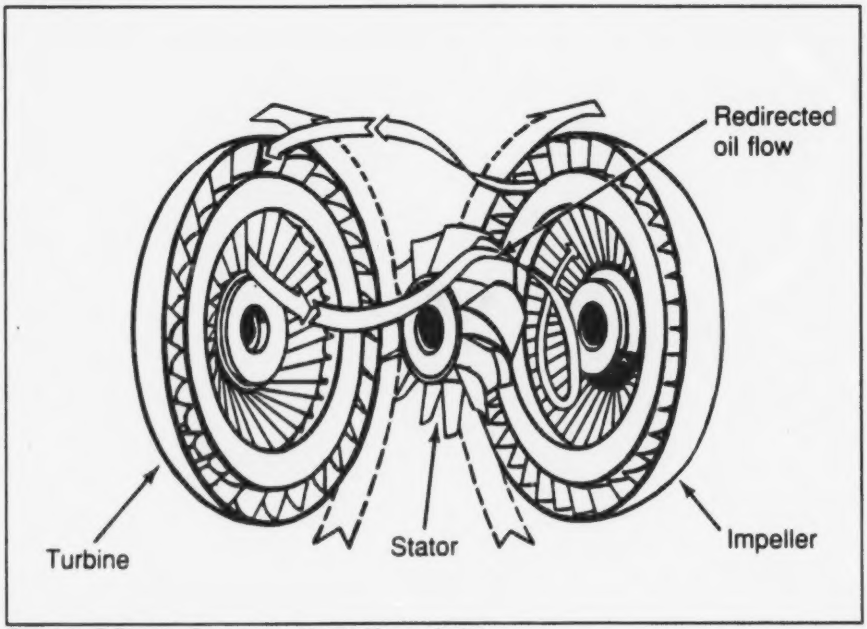
- **Torque multiplier**
    - ☐ A stator—mounted on a one-way clutch that allows it to rotate clockwise but not counterclockwise—is added between the impeller and the turbine.
    - ☐ The stator redirects counterclockwise oil returning from the turbine and changes its direction back to the direction of the impeller. (Figure 9)

      ☑ **NOTE:** Some exceptions to this rule may apply. This statement is true for RWD vehicles, but it does not apply to some FWD vehicles, such as the Acura. Some transmissions are mounted on the driver side; others on the passenger side.

FIGURE 9



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- ☐ Torque multiplication occurs when the fluid is returned to the impeller in a clockwise rotation, causing the impeller to spin *faster* than the turbine and the one-way clutch to lock the stator.

- ☐ The energy in the oil is then used to help turn the impeller, thus increasing the force of the oil driving the turbine and multiplying the torque or twisting force of the engine.

- ☐ Vortex flow occurs at stall and lower speeds.

- ☐ Rotary flow occurs at higher road speeds as the impeller, starter, turbine and fluid all rotate in the same direction at approximately the same speed.

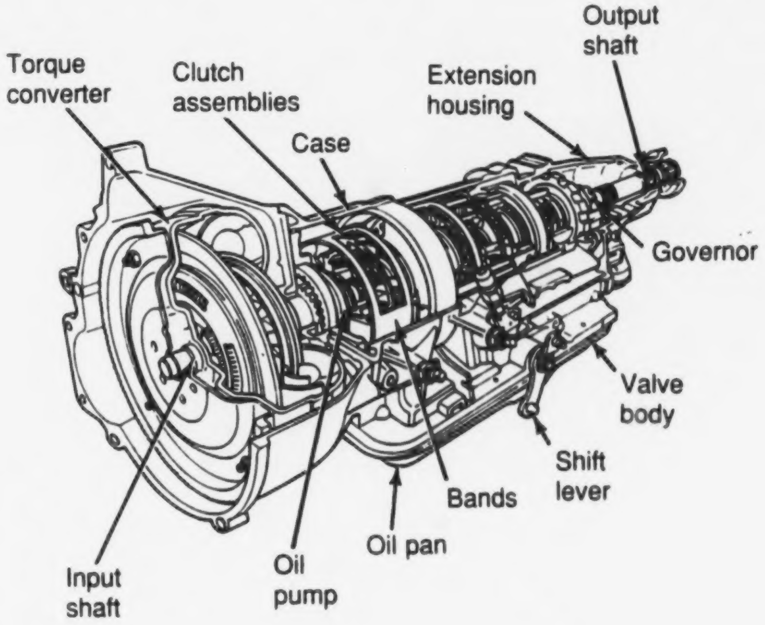
OBJECTIVE 5

Label the basic components of an automatic transmission and an automatic transaxle.

Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

FIGURE 10



Simplified Automatic Transmission

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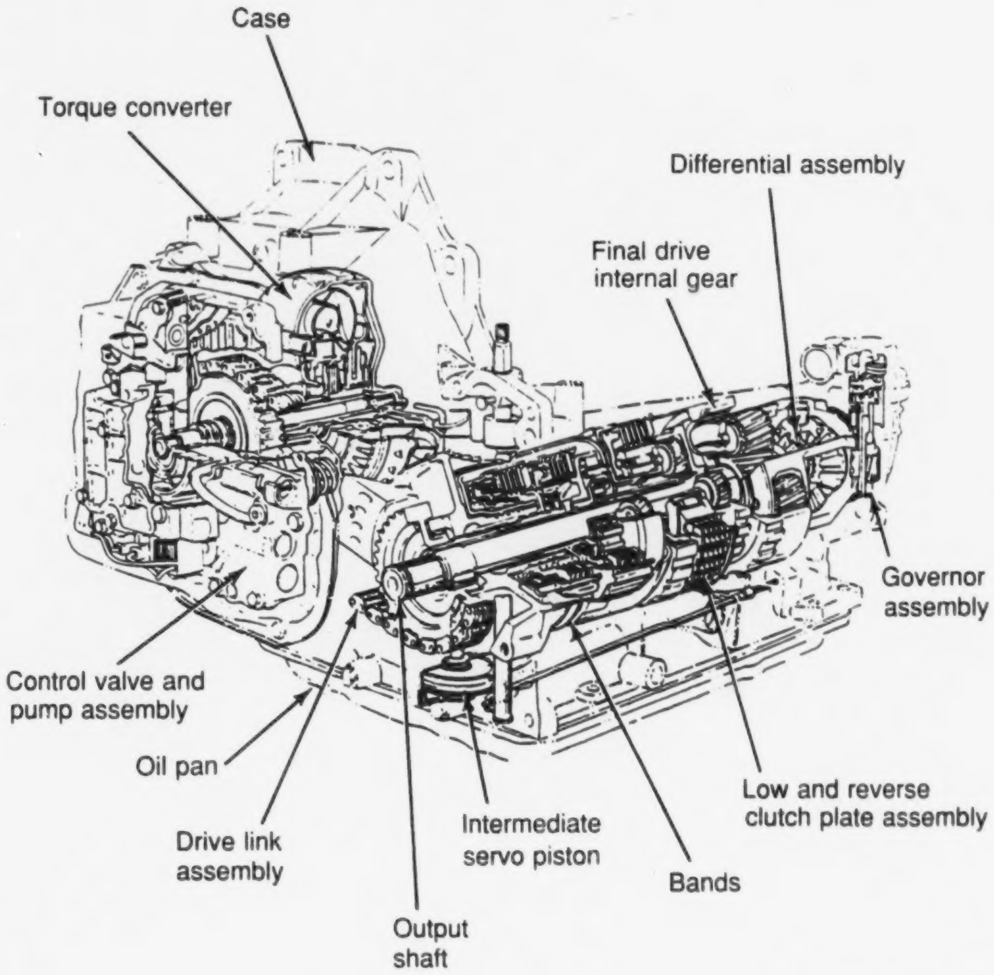
FIGURE 11


Case
Torque converter
Differential assembly
Final drive internal gear
Governor assembly
Control valve and pump assembly
Oil pan
Low and reverse clutch plate assembly
Drive link assembly
Intermediate servo piston
Bands
Output shaft

Automatic Transaxle Assembly
GM THM 125 (3T40)

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OBJECTIVE 6

Optional Activities/
Resources in
Instructor's Guide

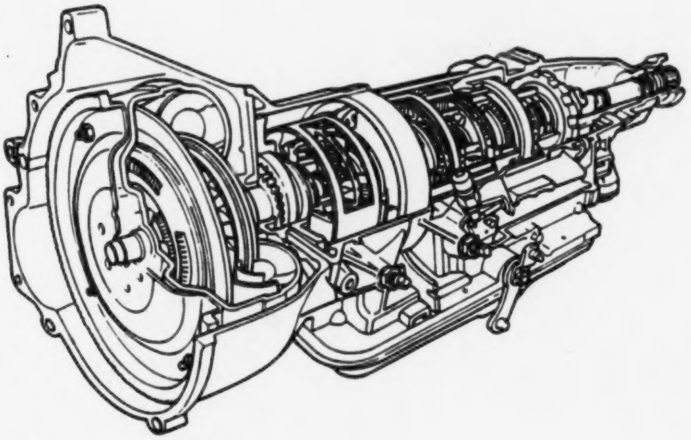
Required Activities/
Resources in
Instructor's Guide

List types of automatic transmissions/transaxles.

WORDS YOU SHOULD KNOW	
electronic continuously variable transmission (ECVT)	a stepless transmission that operates on a system of pulleys and a drive belt; controlled by an electronic clutch-control unit (CCU)
nonplanetary gear transmission	automatic transmission that combines standard transmission gears and power flow with multiple-disc clutch assemblies and a torque converter
stepped-ratio transmission	the normal automotive transmission in which the gear ratios are seen as steps from first gear to fourth or fifth gear, both of which could be overdrive ratios
stepless transmission	a transmission that does not shift to different specific speeds; instead, the gear ratio changes gradually, allowing the engine to run at almost a constant speed; also called a *continuously variable transmission (CVT)*

- **Stepped-ratio transmission** (Figure 12)

FIGURE 12

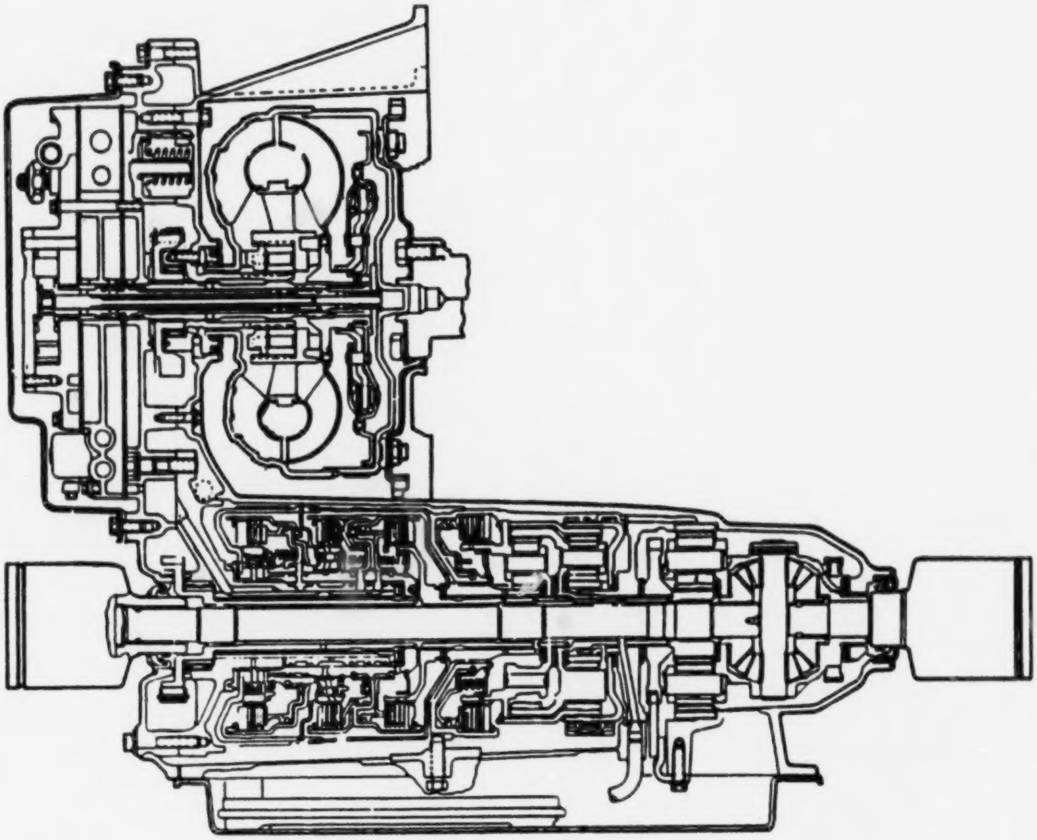


Ford A4LD Automatic Overdrive Transmission

Reproduced from *MOTOR Domestic Transmission Manual*, copyright © 1990, by permission of The Hearst Corporation.

- **Stepped-ratio transaxle** (Figure 13)

FIGURE 13



354

Ford AXOD Automatic Overdrive Transaxle

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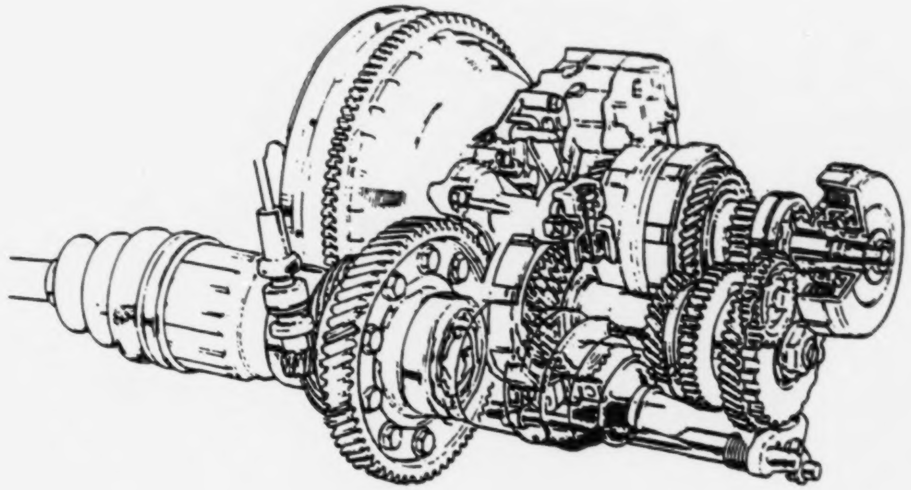
- **Electronic continuously variable transmission (ECVT)**

  ☑ **NOTE:** Ask your instructor to show you an example of an ECVT.

- **Nonplanetary gear transmission** (Figure 14)

FIGURE 14



Hondamatic® Transmission

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OBJECTIVE 7

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

List the advantages and disadvantages of conventional automatic transmissions/transaxles over manual transmissions.

- **Advantages**
  - ☐ Do not require driver to manually select gears
  - ☐ Do not require driver to depress a clutch pedal
  - ☐ Provide a smoother, more consistent transfer of power from engine to transmission

  - Computer controls provide better acceleration and greater fuel economy
  - Weigh less and are relatively less bulky
  - Provide better emission control because engine does not decelerate during shifts

- **Disadvantages**
  - Have more moving parts
  - Are more complex
  - Do not allow engine to operate at maximum efficiency

OBJECTIVE 8

Optional Activities/ Resources in Instructor's Guide

Distinguish between symptoms that require simple service and those that require overhaul or repair.

- **Simple service**
  - Clogged filters
  - Plugged filters
  - Oxidized fluid
  - Burned fluid
  - Routine mileage interval
- **Overhaul or repair**
  - Heavy varnish buildup
  - Extreme burn odor
  - High mileage without previous service
  - Presence of water/coolant

OBJECTIVE 9

Optional Activities/ Resources in Instructor's Guide

State reasons for identifying a transmission before servicing.

- Without this essential information, the technician cannot be sure that the correct parts and procedure will be used.
- The same make and model vehicle may have several transmission options.

- After the vehicle was purchased, a transmission of a different year or model may have been installed.

  ☑ **NOTE:** The specialist must remember that it is the transmission—not the vehicle—that is being serviced.

OBJECTIVE 10

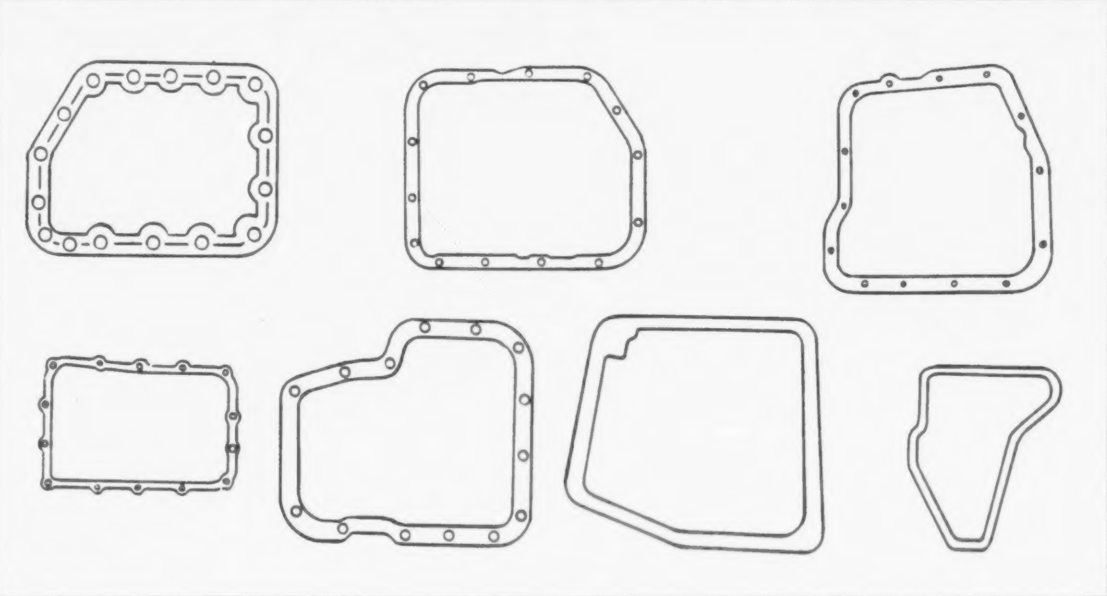
Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

State ways of identifying an automatic transmission before servicing.

- Matching the shape of the oil pan with a pan or pan-gasket chart (Figure 15)

FIGURE 15



- Checking the transmission identification tag or serial number against the service manual's decoding information

  ☑ **NOTE:** The transmission identification tag or serial number is usually attached to or stamped on the case. Updates may occur but may not be reflected on the identification tag.

- Checking the transmission's composition and shape and the location of its external components against the service manual's description

OBJECTIVE 11

Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

Answer questions about automatic transmission fluid.

WORDS YOU SHOULD KNOW

automatic transmission fluid (ATF)	mineral-based oil used in automatic transmissions
coefficient	factor that contributes to produce a result; in ATF, a desired friction

☑ **NOTE:** Manufacturers design their transmissions with specific friction coefficients in mind. The technician should use only the ATF recommended by the manufacturer for the specific make and model being serviced.

- Most ATF is dyed red, but aftermarket "racing" fluids are dyed blue, and Ford CJ is gold.
- Generally, any change in normal ATF color is a cause for concern and a sign that there may be a problem.

  ☑ **NOTE:** There are some exceptions to this rule. For example, some types of additives (Dextron 2D®, Honda 71-76®, Mercron II®) may cause normal ATF to turn dark or have an unpleasant odor.

- A pinkish or milky AFT color indicates water contamination.
- ATF usually has a mild, pleasant odor; if it smells like burned popcorn or rotten eggs, the transmission may have been overheated or abused.
- Filtering of ATF is *critical* to prevent metal particles from damaging friction surfaces.

OBJECTIVE 12

Required Activities/
Resources in
Instructor's Guide

State the functions of automatic transmission fluid.

- Provides a coupling between the engine and the transmission
- Removes heat from the transmission and transfers it to outside air via the transmission's oil cooler
- Lubricates the transmission's moving parts
- Provides pressure to operate clutch pistons and band servos

OBJECTIVE 13

Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

List the effects of too little or too much automatic transmission fluid.

Why do too little and too much ATF lead to aeration?

Why do aerated ATF and too little ATF lower hydraulic pressure?

Why do aerated ATF and too much ATF lead to overheating?

WORDS YOU SHOULD KNOW	
aerated fluid	fluid that has been agitated until foamy and full of air bubbles
varnish buildup	coating of deposits that collects on parts; caused by oxidation and contamination of liquids; can cause binding
oxidation	process occurring when a surface material such as steel combines with air and produces a thin layer of oxide (rust, scale)

- **Effect of too little ATF**
  - Fluid can become aerated, leading to low hydraulic pressure; low hydraulic pressure will cause delays in clutch and band application.
- **Effects of too much ATF**
  - Fluid can become aerated, leading to overheating, oxidation, and varnish buildup.
  - Fluid can be forced from the vent.

OBJECTIVE 14

Optional Activities/
Resources in
Instructor's Guide

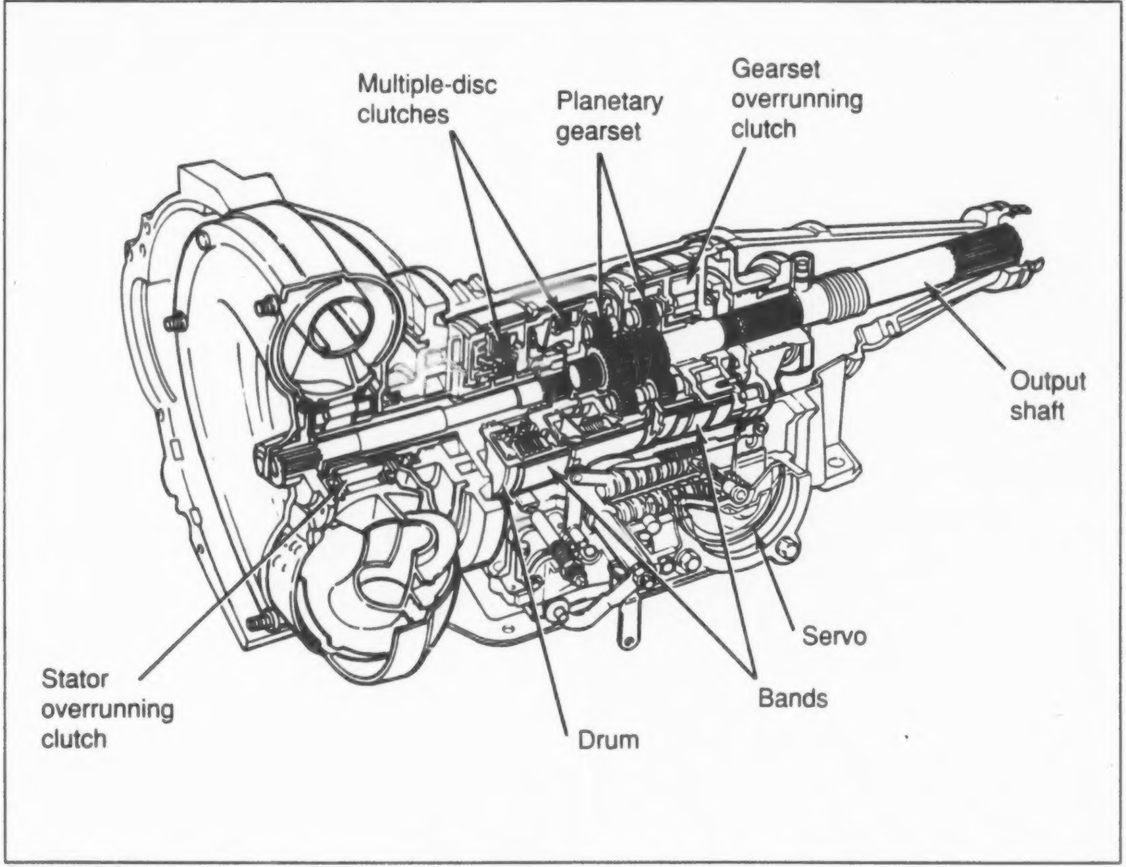
Required Activities/
Resources in
Instructor's Guide

Explain the functions of given friction devices.

WORDS YOU SHOULD KNOW	
coefficient of friction	term referring to the amount of friction between two surfaces
dynamic friction	relative amount of friction between two surfaces turning at different speeds
static friction	relative amount of friction between two stationary surfaces or two surfaces turning at the same speed

WORDS YOU SHOULD KNOW	
friction	resistance to motion between two bodies in contact with each other
friction modifier	an additive that changes the lubricating quality of a fluid
apply devices	devices that control the planetary gearset by applying force that actuates, holds, or drives other parts EXAMPLES: Hydraulically-operated multiple-disc clutches and bands; mechanical one-way (over-running) clutches

FIGURE 16



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- **drum** — cast iron, aluminum, or stamped steel housing splined to a planetary gear; when stopped, stops gear rotation; may be engine driven, in which case it drives forward gear

- **band** — lined metal strap that wraps around a drum; used to stop or hold a drum stationary
- **servo** — hydraulic piston used to apply the band
- **accumulator piston** — piston used to cushion the servo in applying the band or clutch quickly and smoothly

  ☑ **NOTE:** The accumulator piston is not visible in Figure 16. Its location varies with transmission type and manufacturer.

- **multiple-disc clutch** — stack of discs arranged in alternate fashion, the driving discs splined to the clutch hub and the driven discs splined to the clutch drum; when the clutch is applied, the discs press together to lock the clutch hub and drum together

  ☑ **NOTE:** A piston in the clutch drum squeezes the plates together when oil pressure from the transmission is applied to the piston. Spring pressure releases the discs when oil pressure drops.

- **overrunning (one-way) clutch** — mechanism that locks the component in one direction and allows rotation in the other

OBJECTIVE 15

Optional Activities/
Resources in
Instructor's Guide

Match automatic transmission gear indicators/gears with their functions.

- **park gear (P)** — locks the drive wheels to prevent vehicle movement
- **reverse gear (R)** — allows the vehicle to move backwards
- **neutral gear (N)** — allows the engine to run without moving the vehicle
- **drive (high) gears (D)** — allow vehicle speed to increase while engine speed decreases; provide automatic shifts from low to high gear and from high to low gear as necessary
- **intermediate gears (I)** — prevent high-gear operation
- **low gears (L)** — multiply the engine's torque so that there will be enough power to move the vehicle; provide engine braking if needed

ASSIGNMENT SHEET

INTRODUCTION TO AUTOMATIC TRANSMISSIONS AND TRANSAXLES

1

Name ______________________________ Score __________

OBJECTIVE 2

Solve problems involving Pascal's Law.

INSTRUCTIONS

Functional Reading
- Follow written instructions

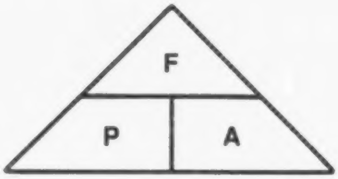
Operation and Calculation
- Calculate with whole numbers
- Calculate with decimals
- Solve formulae and equations
- Converts units of measure

Math Application
- Select/apply mathematical formula

Study the examples below, then use Pascal's Law and the memory triangle to solve the following problems involving pressure, force, and area.

Part 1

Memory Triangle:



Cover the part you need to determine. The remaining portion of the triangle shows what you need to do to find the answer. For example, if you need to find the area, cover the A (area); area equals force divided by pressure.

EXAMPLES: 1. Calculating pressure (psi and kPa)

How much pressure will be exerted by 200 pounds of force — in pounds per square inch (psi) and kilopascals (kPa) — on a piston of 1 square inch?

Total Pressure = Force Exerted ÷ Piston Area

= 200 lb/1 sq in

= 200 psi *or*

= 1379 kPa (200 psi × 6.895)

2. Calculating applied force (pounds or Newtons)

How much force—in both pounds and Newtons—is produced by a 500-psi pressure exerted on an output piston with an area of 1 square inch?

Force = Piston Area × Total Pressure

= 500 psi × 2 sq in

= 1,000 lb *or* 4,400 Newtons (1,000 × 4.4)

3. Calculating area (square inches or square centimeters)

The force generated by the hydraulic system is 500 pounds, and the pressure exerted is 200 psi. What is the piston area?

Area = Force ÷ Pressure

= 500/200

= 2.5 square inches *or* 16.35 sq cm (2.5 in × 6.54)

Part 2

PROBLEMS

1. How much pressure will be exerted by 600 pounds of force—in pounds per square inch (psi) and kilopascals (kPa)—on a piston of 1.5 square inches?

   psi = ______________

   kPa = ______________

2. How much force—in both pounds and Newtons—is produced by a 150-psi pressure exerted on an output piston with an area of 2 square inches?

   Pounds ______________

   Newtons ______________

3. The force generated by the hydraulic system is 240 pounds, and the pressure exerted is 120 psi. What is the piston area in square inches and square centimeters?

   Square inches = ______________

   Square centimeters = ______________

4. How much pressure will be exerted by 250 pounds of force—in pounds per square inch (psi) and kilopascals (kPa)—on a piston of 3 square inches?

   psi = ______________

   kPa = ______________

5. How much force—in both pounds and Newtons—is produced by a 400-psi pressure exerted on an output piston with an area of 1 square inch?

   Pounds ______________

   Newtons ______________

6. How much pressure will be exerted by 300 pounds of force—in pounds per square inch (psi) and kilopascals (kPa)—exerted on a piston of 6 square inches?

   psi = ______________

   kPa = ______________

7. How much force—in both pounds and Newtons—is produced by a 100-psi pressure exerted on an output piston with an area of 2 square inches?

   Pounds ______________

   Newtons ______________

8. The force generated by the hydraulic system is 275 pounds, and the pressure exerted is 100 psi. What is the piston area in square inches and square centimeters?

   Square inches = ______________

   Square centimeters = ______________

OBJECTIVE SHEET

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

INTRODUCTION

As an automotive transmission specialist, you will need to understand how automatic transmissions shift gears without driver assistance. How do these transmissions shift from low into an intermediate gear (when present) and then into high gear as the car picks up speed? When the driver wants to pass and pushes the accelerator to the floorboards, how does the "kickdown" system in automatic transmissions produce a downshift?

All of these automatic shifting actions are produced hydraulically by oil pressure. *Hydraulics* is the study of liquid, or fluid, pressure to transmit force and motion. Hydraulic systems use liquids for this purpose because liquids cannot be compressed. In an automatic transmission, the pump is the source of fluid flow, and various valves and passages provide the resistance needed to develop pressure. These components interact with one another to control upshifts and downshifts.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS	
PREREADING:	Read the material on hydraulics in your textbook.
WRITING:	Write a list of cautions and warnings related to servicing an automatic transmission hydraulic system. Refer to Job Sheet 1 in this unit and to various service manuals.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Label basic hydraulic-related components of a modern four-speed automatic transmission/transaxle.
2. Describe the functions of basic hydraulic-related automatic transmission components.
3. Label the parts of a typical throttle linkage on a rear-wheel drive transmission.
4. State the purpose of a vacuum modulator.
5. List problems caused by a defective vacuum modulator.
6. State the purpose of the transmission governor.
7. Label the parts of a typical governor assembly.
8. List possible sources of transmission fluid leaks.
9. Describe common methods of identifying leaks.
10. Label the basic parts of a valve-body assembly.
11. Identify types of valves used in automatic transmission valve bodies.
12. Match types of valve-body valves with their characteristics.
13. Label the basic parts of a typical servo assembly.
14. Identify types of servo operating linkages.
15. State the purposes of the accumulator.
16. Service a transmission. (Job Sheet 1)
17. Remove and replace extension housing bushing and seal (including microsleeve). (Job Sheet 2)
18. Check and adjust or replace manual shift valve and throttle valve (TV) linkages/cables. (Job Sheet 3)
19. Inspect and replace vacuum modulator, lines, and hoses. (Job Sheet 4)
20. Inspect and replace governor assembly. (Job Sheet 5)

21. Remove and repair or replace valve body. (Job Sheet 6)

22. Remove and repair or replace a servo assembly. (Job Sheet 7)

23. Inspect an accumulator. (Job Sheet 8)

INFORMATION SHEET — SERVICING HYDRAULIC SYSTEM COMPONENTS — 2

OBJECTIVE 1

Optional Activities/
Resources in
Instructor's Guide

Label basic hydraulic-related components of a modern four-speed automatic transmission/transaxle.

☞ Your instructor will display basic hydraulic-related components. You must be able to label the following components:

- Reverse servo
- Intermediate servo
- Overdrive servo
- Case
- Valve-body assembly
- Oil pan screen
- Oil pan gasket
- Oil sump pan
- Governor assembly
- Dipstick and filler tube

OBJECTIVE 2

Required Activities/
Resources in
Instructor's Guide

Describe the functions of basic hydraulic-related automatic transmission components.

- **automatic transmission** — changes forward gear ratios automatically
- **accumulator** — stores hydraulic energy to regulate shift quality
- **bushing** — provides a bearing surface for rolling parts

  ☑ **NOTE:** A bushing is a one-piece replaceable cylinder.

- **case** — houses the transmission internal components
- **extension housing assembly** — houses rear part of transmission and output shaft coupling
- **gasket** — seals two parts together to contain fluid and keep out contaminants

  ☑ **NOTE:** Gaskets may be made of rubber, plastic, cork, paper, or other soft material.

- **oil-pan filter** — screens dirt and metal particles from transmission fluid

- **oil seal** — prevents oil leaks around a shaft

  ☑ **NOTE:** Oil seals are ring-shaped assemblies that may be made of sheetmetal, rubber, or Teflon®.

- **piston** — transfers hydraulic force

- **pump** — transfers fluid from one point to another and also creates hydraulic pressure

- **servo** — converts hydraulic pressure into mechanical motion

- **valve** — controls fluid flow and pressure

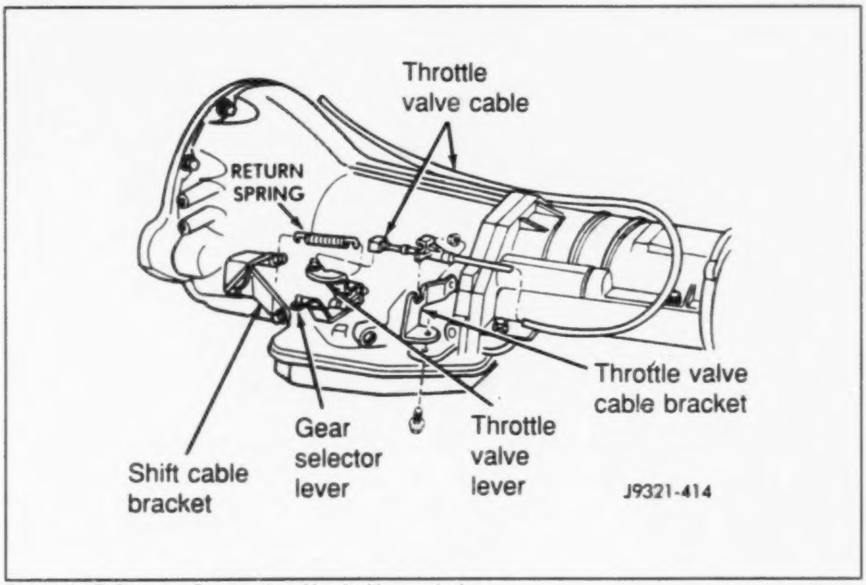
- **valve body** — controls pressures and direction of fluid flow

OBJECTIVE 3

Optional Activities/
Resources in
Instructor's Guide

Label the parts of a typical throttle linkage on a rear-wheel drive transmission.

FIGURE 1



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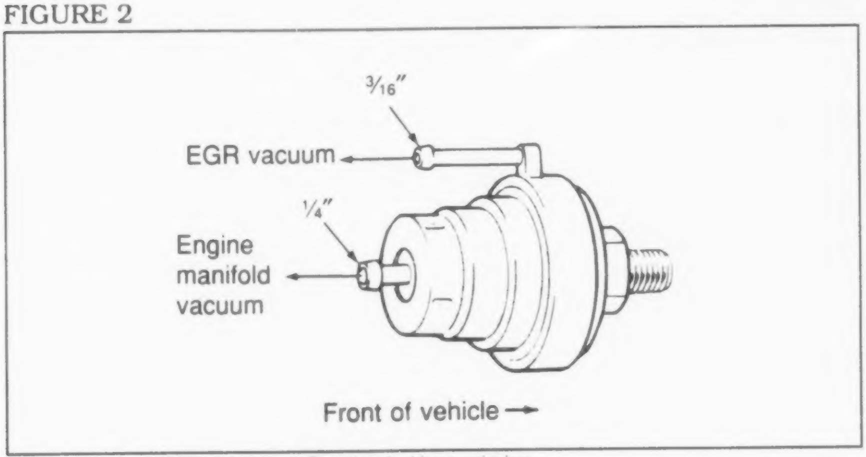
OBJECTIVE 4

State the purpose of a vacuum modulator.

Senses engine load and causes the hydraulic valve to change pressure relative to that load

☑ **NOTE:** Some Ford transmissions have a dual-area vacuum-control diaphragm unit. These units use vacuum from both the exhaust-gas recirculation (EGR) system and the engine manifold. (Figure 2)

FIGURE 2



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OBJECTIVE 5

Required Activities/
Resources in
Instructor's Guide

List problems caused by a defective vacuum modulator.

- Soft upshifts or downshifts
- Delayed upshifts
- Slippage in low, drive, or reverse
- Transmission overheating
- Transmission fluid burning by the engine

OBJECTIVE 6

Required Activities/
Resources in
Instructor's Guide

State the purpose of the transmission governor.

Controls (or governs) hydraulic-circuit pressure on one end of the shift valve

☑ **NOTE:** The vacuum modulator and governor work together to determine shift points. The governor applies pressure to one end of the shift-control valve to cause upshifts, and the modulator applies pressure to the other end of the shift-control valve to delay upshifts, thus controlling upshifts and downshifts.

OBJECTIVE 7

Label the parts of a typical governor assembly.

Optional Activities/
Resources in
Instructor's Guide

☞ Your instructor will display the parts of a typical governor assembly. You must be able to label the following parts:

- Governor shaft
- Output shaft
- Drive gear
- Driven gear
- Primary weight
- Secondary weight
- Primary check ball
- Secondary check ball
- Secondary spring
- Oil seal ring

☑ **NOTE:** Chrysler uses a FWD valve-type governor shaped like a large letter U to permit easy removal and replacement. It is located on the transaxle transfer shaft. Ford uses a flyweight-type governor assembly on many automatic transmissions and transaxles. It consists of a spool-type governor valve, primary weights, secondary weights and springs, the governor body, and the governor assembly drive gear to produce governor pressure.

OBJECTIVE 8

List possible sources of transmission fluid leaks.

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

☞ Your instructor will show you where each of the leak sources is located, on both a RWD and FWD vehicle.

- Case
- Converter
- Cooler, connectors, and plugs
- Electrical connector seal
- Extension oil seal assembly
- Extension-to-case seal
- Governor cover
- Manual shaft seal
- Oil fill-tube seal
- Oil pan
- Oil pump seal assembly
- Oil pump-to-case seal
- Servo cover
- Speedo seal
- TV cable seal
- Vent

OBJECTIVE 9

Optional Activities/
Resources in
Instructor's Guide

Describe common methods of identifying leaks.

- **Inspecting visually** — examining seals, joints, and components in suspect area for evidence of leakage
- **Cleaning and inspecting visually** — cleaning of transmission housing and engine; bringing the engine and transmission to operating temperature; and visually examining the transmission-housing seals and joints with a trouble light
- **Using compressed air** — filling component with compressed air and submerging in water or spraying with soapy water solution to check for the escape of air bubbles that would indicate a leak

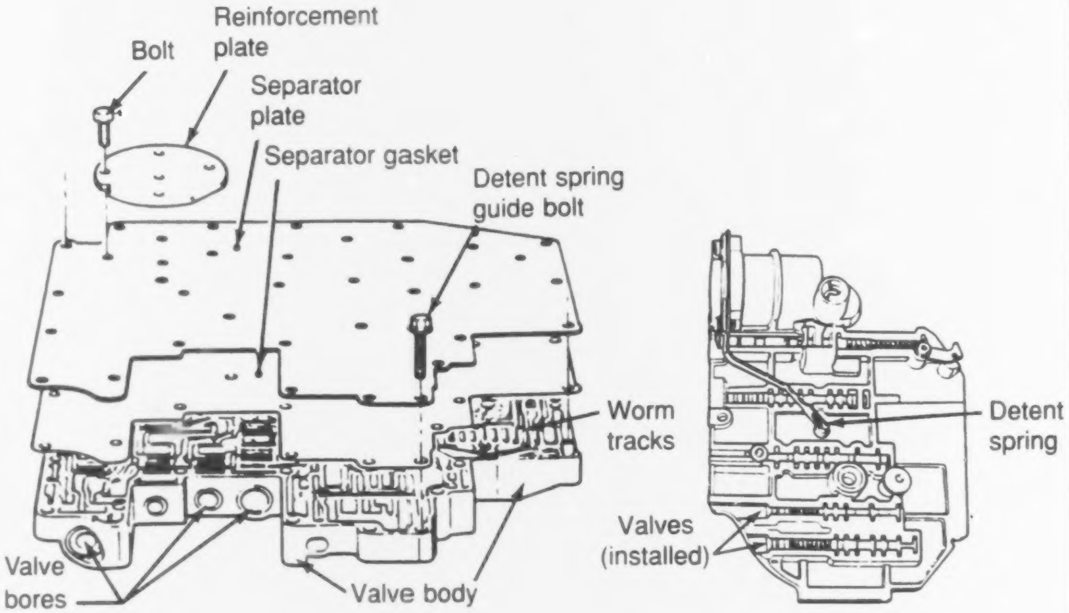
  EXAMPLE: Torque-converter leak test
- **Using vacuum tester** — Using a vacuum tester to determine whether the modulator will hold vacuum

  EXAMPLE: Vacuum modulator
- **Using leak-detecting additive** — Spraying suspect area with leak-detecting additive and then passing an ultraviolet light over the area to highlight leak
- **Using leak-detecting powder** — Spraying suspect area with leak-detecting powder and looking for fluid trails

OBJECTIVE 10 Label the basic parts of a valve-body assembly.

Optional Activities/
Resources in
Instructor's Guide

FIGURE 3



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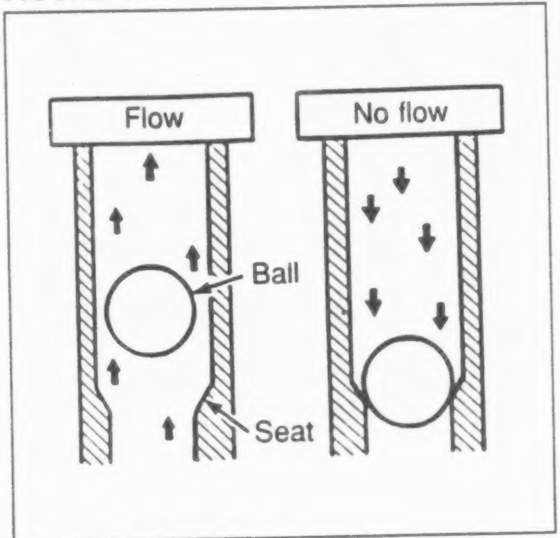
OBJECTIVE 11

Optional Activities/
Resources in
Instructor's Guide

Identify types of valves used in automatic transmission valve bodies.

- **Check-ball valve** (Figure 4)

FIGURE 4



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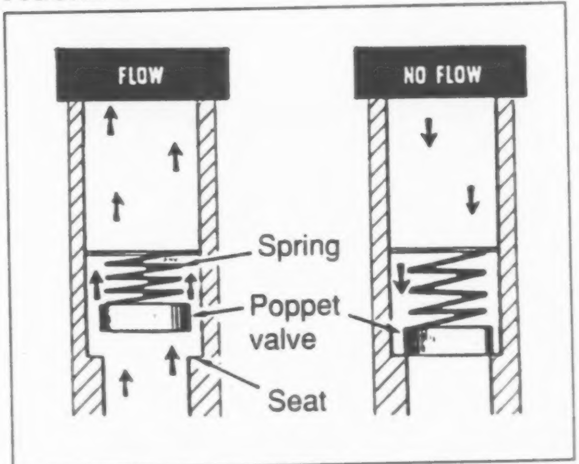
- **Poppet valve** (Figure 5)

FIGURE 5



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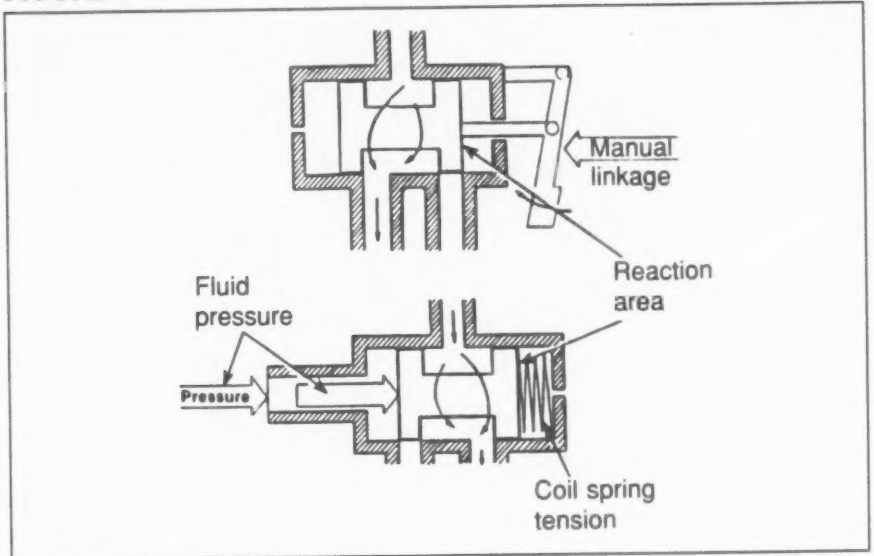
- **Balance valve** (Figure 6)

FIGURE 6



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OBJECTIVE 12

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Match types of valve-body valves with their characteristics.

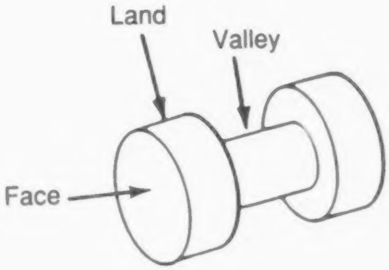
WORDS YOU SHOULD KNOW	
one-way check valve	type of switching valve that allows fluid to pass in one direction only, and then only when pressure is great enough to unseat the valve
two-way check valve	type of switching valve that controls fluid flow from two separate hydraulic circuits, and allows them to share a single fluid passage
face	flat area of spool valve land to which hydraulic force is applied
land	large outer circumference of a spool valve that slides against the valve bore

WORDS YOU SHOULD KNOW

valley	the depression between spool valve lands

☑ **NOTE:** A simple spool valve resembles a sewing thread spool. It has two lands, four faces (two outer and two inner faces), and a valley between the two inner faces (Figure 7)

FIGURE 7



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- **check-ball valve** — type of one- or two-way check valve in which fluid pressure or manually operated linkage forces ball against passage to stop fluid flow; pressure on other side unseats the ball

- **poppet valve** — type of one-way check valve in which fluid passes through the valve only after hydraulic pressure exceeds the spring pressure holding a flat disc or ball against its seat

  ☑ **NOTE:** Generally, these valves "pop" open, thus their name.

- **spool valve** — type of hydraulic control valve that slides back and forth in machined bores as hydraulic pressure is applied to the faces of its various lands

  ☑ **NOTE:** Spool valves are the most-often-used valves in the valve body. They are machined to fit their bores so closely that even a human hair between the land and the bore can prevent proper operation. For this reason, it is *essential* that everything be kept spotlessly clean during valve-body service.

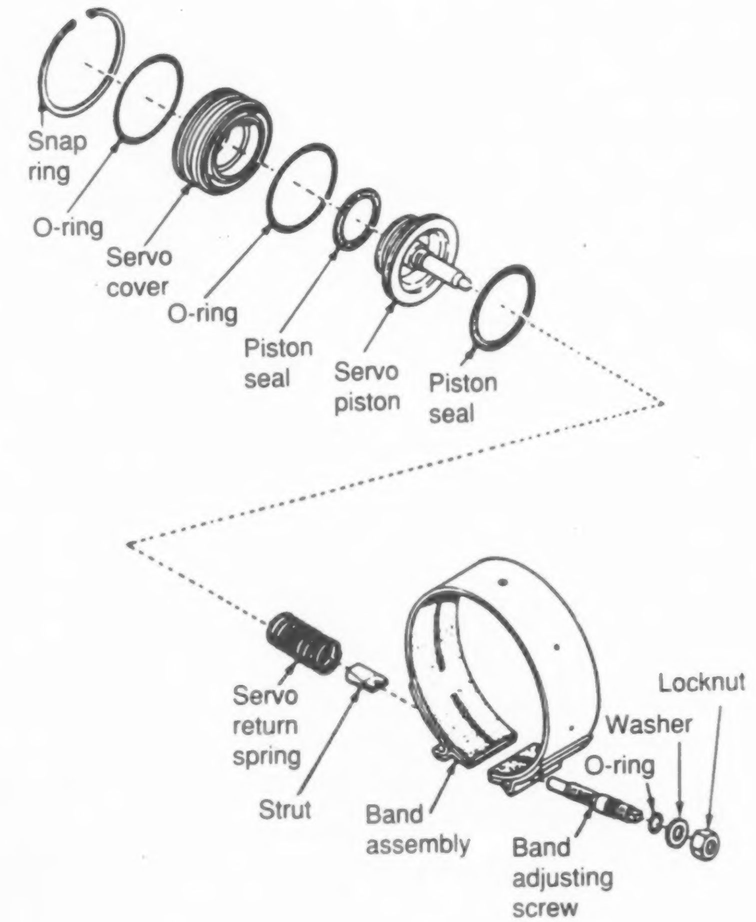
- **balance valve** — spool valve and spring combination used to regulate hydraulic-system pressure; some also use auxiliary lever force

OBJECTIVE 13

Optional Activities/
Resources in
Instructor's Guide

Label the basic parts of a typical servo assembly.

FIGURE 8



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OBJECTIVE 14

Identify types of servo operating linkages.

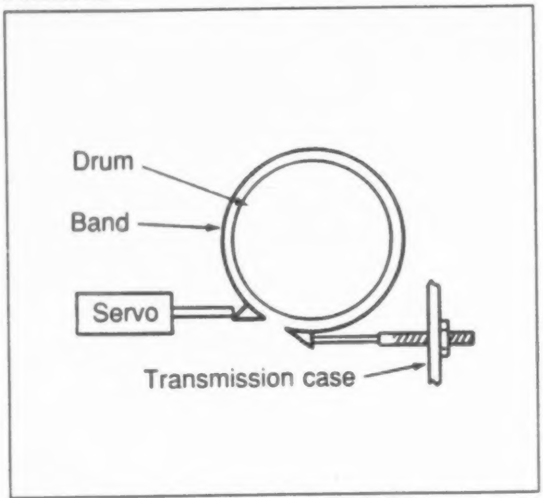
Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

WORDS YOU SHOULD KNOW	
band	lined metal strap that wraps around a drum; used to stop or hold the drum stationary
fulcrum	the support and pivot point of a lever
cantilever	a lever that is anchored and supported at one end by its fulcrum and that provides an opposing force at its opposite end
straight linkage	acts from either or both sides of the band, using a straight rod or strut to transfer force from the servo piston directly to the free end of the band ☑ **NOTE:** The straight linkage is the most common type of linkage.
cantilever linkage	acts on both ends of an unanchored band, clamping the ends together and tightening the band around the drum
lever linkage	uses a lever to move a rod or strut that applies the band and multiplies force when the servo cannot directly apply pressure ☑ **NOTE:** The apply lever linkage bends the force of the servo that acts against the band. Usually, application force is increased because the lever is longer on the servo side of the fulcrum than it is on the strut side

- **Straight linkage** (Figure 9)

FIGURE 9



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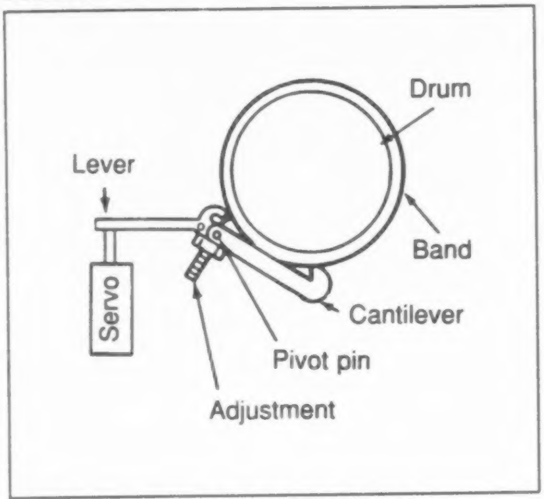
- **Cantilever linkage** (Figure 10)

FIGURE 10



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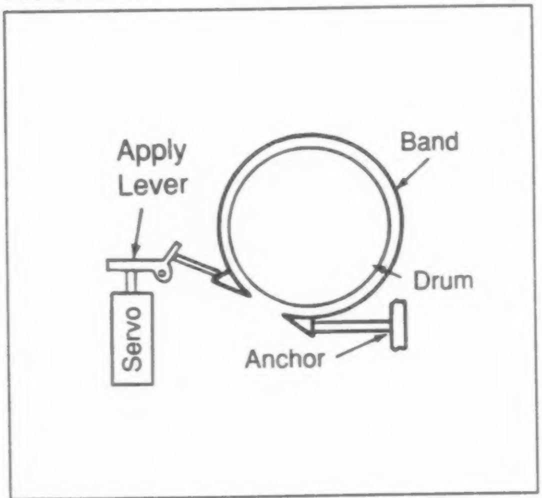
- **Lever linkage** (Figure 11)

FIGURE 11



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OBJECTIVE 15

Optional Activities/
Resources in
Instructor's Guide

State the purposes of the accumulator.

- Acts as a shock absorber to cushion band or clutch application
- Assists the servo in applying the brake band or clutch quickly, yet smoothly

OBJECTIVES 16-23

Complete Job Sheets 1-8.

JOB SHEET 1

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Name ______________________________

OBJECTIVE 16 **Service a transmission.**

INTRODUCTION

Servicing the transmission is a routine part of automatic transmission service. Such service requires that the technician regularly check fluid levels and replenish as necessary, perform a visual inspection of the transmission fluid, and replace the transmission fluid and/or filter as necessary.

Fluid levels should be checked every time the engine oil is changed and at the time and mileage intervals specified by the vehicle manufacturer. The correct transmission-fluid level is at FULL or between a range indicated on the dipstick.

Automatic transmission fluid should be clear and free of foreign material and particles. If the fluid is discolored or burnt, it may have been overheated and should be checked. Routine service should *not* be performed if the technician discovers heavy varnish, extreme burn odor, high mileage without previous service, or the presence of water or fluid. These conditions call for higher level procedures. Transmission fluid should also be changed at the service intervals prescribed by the vehicle manufacturer. When replacing fluid, it is important that the technician use only the type recommended in the service manual for the make and model being serviced.

Fiber and paper filters should be changed every time the technician changes the transmission fluid. This change will occur every 25,000 miles (more often in severe service) regardless of manufacturer's recommended fluid-change intervals. Screen filters should be cleaned any time a transmission is serviced. The filter should be replaced if it is torn or broken, or has a varnish buildup on its mesh surface.

The transmission pan gasket is normally the only gasket replaced when servicing in-car transmissions. It is usually made of cork or composition material. Gaskets used in the rest of the transmission may be made of synthetic materials, plastic, or paper.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Manufacturer-recommended transmission fluid
- Large, 5-quart drain pan
- Parts-cleaning solution
- Stiff brush
- Gasket scraper or putty knife
- Replacement filter O-ring or seal
- Replacement pan gasket
- Replacement paper, fiber, or screen filter as required
- Basic hand tool set
- Lubricating oil/grease
- Shop towels

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

Functional Math
- Make measurements

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Check fluid level. Yes No

1. Drive the vehicle for several miles to bring the transmission to normal operating temperature. ___ ___

☑ **NOTE:** Check your service manual. Some vehicle manufacturers are very specific on the mileage necessary to bring the transmission to operating temperature.

2. Position the vehicle on a flat surface. ___ ___
3. Engage the parking brake and start the engine. ___ ___

⚠ **WARNING:** Be sure that exhaust ventilation equipment is installed before starting the engine in an enclosed area. Carbon monoxide in exhaust gases can cause injury and death.

---

4. With engine at curb idle, move the transmission shift lever slowly through all gear ranges, ending in the gear (park or neutral) recommended by the vehicle manufacturer. ___ ___
5. Exit the vehicle and open the hood. ___ ___

Yes No

6. Remove the transmission-fluid dipstick and carefully touch the wet end to determine whether the fluid is cool, warm, or hot. ____ ____

7. Wipe the dipstick clean with a shop towel, and reinsert dipstick into its tube until seated. ____ ____

8. Remove the dipstick and read the fluid level.

   - If fluid felt cool or warm, level should be between dimples above FULL mark. ____ ____

   - If fluid felt hot, level should be at or in area marked HOT. ____ ____

9. If needed, add just enough of the manufacturer-recommended transmission fluid to raise the level from the ADD mark to the FULL mark. ____ ____

   ☑ **NOTE:** Remember the marks on the dipstick indicate pints—not quarts—as on the engine-oil dipstick.

⚠ **CAUTION:** Do not overfill the transmission. Refill capacities listed in the service manual are approximate. Correct fluid level should be determined by checking the mark on the dipstick rather than by the amount added.

---

10. Reinsert and seat the dipstick. ____ ____

PROCEDURE

Inspect automatic transmission fluid.

1. Remove the transmission-fluid dipstick. ____ ____

2. Visually inspect the fluid for discoloration. ____ ____

3. Sniff the fluid for burned smell. ____ ____

4. If the fluid is discolored or has a burned smell, check with your instructor. ____ ____

   ☑ **NOTE:** The transmission may have some internal drainage that could be aggravated by a fluid change.

PROCEDURE

Drain and replace automatic transmission fluid. Yes No

1. Safely raise automobile to proper working height on a hoist. ____ ____

⚠ **CAUTION:** Obtain your instructor's permission before operating the hoist. Be careful of hot ATF, and avoid contact with hot exhaust parts. Serious burns can result.

---

2. Make a visual inspection.
   - External leaks in transmission linkage lines ____ ____
   - Tightness of the engine-to-transmission attaching bolts ____ ____
   - Condition and tightness of the transmission mount ____ ____
   - Condition of the transmission cooling lines (tight, bent, or cracked?) ____ ____
   - Condition of the universal joint and center support ____ ____
3. Identify the transmission. ____ ____
4. Ensure that all the parts you need to complete the service are available. ____ ____
5. Place the drain pan under the transmission pan. ____ ____
6. Remove all pan bolts except two at opposite corner from which you will drain. ____ ____

⚠ **WARNING:** Transmission fluid in a recently driven vehicle is HOT. Ease out bolts to avoid splashing transmission fluid.

☑ **NOTE:** Transmission fluid may also be drained by removing the drain plug, if there is one.

	Yes	No
7. Loosen the two remaining pan bolts.	____	____
8. While supporting pan, carefully pry the pan loose with a scraper or putty knife, allowing fluid to drain.	____	____
9. Remove the two remaining bolts, oil pan, and oil-pan gasket.	____	____
10. Scrape all traces of the gasket from the oil-pan mating surface with a putty knife or gasket scraper, taking care not to damage the sealing surfaces of the pan.	____	____
11. Thoroughly clean the oil pan with parts-cleaning solution and let it air dry or blow dry with compressed air.	____	____

⚠ **CAUTION:** Do not use shop towels or rags to dry transmission parts. The lint on the cloth gets into the valve body and causes erratic or abnormal transmission operation.

	Yes	No
12. Clean the gasket mating surface of the case, taking care not to get pieces of the gasket into the cavity of the case.	____	____

⚠ **CAUTION:** Use care not to damage the sealing surfaces of the housing when scraping. Aluminum cases can be gouged easily by a scraper, resulting in a fluid leak.

	Yes	No
13. Remove the converter cover and check to see if the converter has a drain plug.	____	____
14. If there is a drain plug, remove it and allow fluid from the converter to drain into the drain pan.	____	____
15. Reinstall the converter drain plug if removed.	____	____
16. Remove the filter screen screws, bolts, or clamps and remove the filter and O-ring or gasket.	____	____

Yes No

17. If entire filtering surface of the screen is not visible, clean it with parts-cleaning solution and let it air dry or dry it with compressed air. ____ ____

18. Replace paper or synthetic fiber filters. ____ ____

19. Install new O-ring, or gasket, lubricated with clean oil, onto filter screen. ____ ____

20. Reinstall filter assembly on valve body, torquing to manufacturer's specifications. ____ ____

⚠ **CAUTION:** Overtightening the filter can distort the valve body and prevent its proper operation.

☑ **NOTE:** Some Ford C4 filters have a throttle-pressure relief valve that is exposed when the filter is removed. Because this valve will fall out when the filter is removed, it must be reinstalled properly before attaching a new filter.

21. Check the mating surface on the oil pan. ____ ____

22. If the mating surface is not distorted or bent, reinstall the oil pan on the case, using a new gasket; if distorted, straighten the pan or reinstall a new pan and gasket. ____ ____

⚠ **CAUTION:** Do not use gasket cement. If the gasket must be held in place, use a little grease.

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23. Torque pan bolts in a crisscross pattern to manufacturer's specifications. ____ ____

⚠ **CAUTION:** The transmission pan must be tightened in a crisscross pattern to ensure that the gasket will not be pinched or broken. Otherwise, leaks develop.

---

24. Install drain plug, if applicable, torquing to manufacturer's specifications. ____ ____

25. Lower the vehicle to the ground. ____ ____

	Yes	No
26. Refill the transmission with manufacturer-recommended amount and type of transmission fluid.	____	____
27. Start engine and move shift lever through all gear positions.	____	____

⚠ **WARNING:** Be sure that exhaust ventilation equipment is installed before starting the engine in an enclosed area. Carbon monoxide in exhaust gases can cause injury and death.

	Yes	No
28. Check fluid level and correct as necessary, following procedure above for checking fluid level.	____	____
29. Road-test vehicle (with instructor's permission) and check for proper transmission operation in all gear positions.	____	____
30. Check fluid level after road test, and check for leaks.	____	____
31. Clean work area and return equipment and materials to proper storage.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications: refilled to manufacturer-specified refill capacity.	4	3	2	1
Product meets manufacturer's adjustment specifications: fasteners tightened to manufacturer's specifications.	4	3	2	1
Product includes proper components/materials: filled with manufacturer-recommended transmission fluid; correct replacement parts used.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

JOB
SHEET 2

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Name ______________________________

OBJECTIVE 17

Remove and replace extension housing bushing and seal (including microsleeve).

INTRODUCTION

The extension housing slides over and supports the output shaft. The housing uses a gasket or O-ring on the front and a seal on the rear to prevent oil leakage. The system may also include a protective microsleeve (axle saver, converter saver). The housing is most often made of aluminum, but it may be made of cast iron.

The transmission specialist can replace the metal-clad seals at the shift lever and the output shaft in the extension housing without removing the transmission from the vehicle. Because replacement of the shift-lever seal normally requires that the oil pan be removed, the best time to replace the seal would be during a regular service procedure when the pan has already been removed.

Replacement of the extension-housing seal requires that the transmission specialist remove the drive shaft. Once the drive shaft has been removed, it is a simple task to remove and replace the extension-housing seal.

The cause for failure in many extension-housing seals is a worn bushing in the extension housing. Special pullers/installers make it possible to remove and replace the extension-housing bushing without removing the transmission from the vehicle.

Guidelines

- Automatic transmissions and transaxles can vary in small ways. Always keep subassembly parts grouped together in a logical sequence. This will help you find the right parts and will greatly aid in reassembly.
- Use any special tools recommended by the vehicle manufacturer, and be sure that you know how to use them correctly.
- Always make match marks on the rear universal joints and the drive shaft to aid in reassembly.

- Be careful not to nick or scratch the ground surface on the sliding spline yoke during removal and installation of the drive shaft assembly.

- Before installing a new seal, inspect the sealing surface of the universal joint yoke for scoring. Also inspect the counterbore of the housing for burrs. Remove burrs with a crocus cloth.

- After installation, check for leaks in housing-seal areas and check transmission fluid level, filling to proper level as specified by vehicle manufacturer.

- If the sealing surface of the component (yoke, torque converter input hub) is grooved or scarred, it may be saved by the installation of a microsleeve, if appropriate. Otherwise, the damaged component should be replaced because the seal will not seal around a damaged surface.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Appropriate seal and bushing removing and installing tools
- Basic hand tool set
- Other equipment and supplies as required by procedure

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

☑ **NOTE:** Refer to the appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Yes No

Process Evaluation Criteria:

1. Consulted appropriate service manual. ___ ___
2. Safely raised and supported vehicle. ___ ___
3. Match-marked drive shaft/drive axle shaft before removal. ___ ___
4. Removed bushing using correct tool. ___ ___
5. Installed bushing in correct position. ___ ___
6. Installed seal in proper direction. ___ ___

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
7. Installed microsleeve if appropriate.	____	____
8. Used a suitable seal driver for installation.	____	____
9. Aligned reinstalled shaft with match marks made at removal.	____	____
10. Test drove vehicle and checked for leaks.	____	____
11. Returned vehicle to service.	____	____
12. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications: drive shaft aligned and in place.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1

Product appearance meets performance requirements: housing and seal areas do not leak.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

SERVICING HYDRAULIC SYSTEM COMPONENTS

Name ______________________________

OBJECTIVE 18

Check and adjust or replace manual shift valve and throttle valve (TV) linkages/cables.

INTRODUCTION

If an automatic transmission is to function properly, driver commands must be transferred into transmission responses. For years, linkage has been used to accomplish this. To compensate for design variations and vehicle wear, most automatic transmission linkages are adjustable. Also, any time a transmission is removed from the vehicle, the linkage settings are disturbed.

When performing manual and TV linkage service, the specialist should also check and adjust the kickdown linkage, if used, and the neutral safety switch, if adjustable. Because of the many variations among vehicle models, follow the guidelines below. For specific inspection, adjustment, and replacement procedures, refer to the proper service manual.

Guidelines

For inspecting manual linkage and determining whether adjustment is needed

- Always make the inspection with the parking brake set and the ignition off.
- Move the selector lever through all of its ranges, observing the gear-range pointer as you feel the internal detents. You should feel the detent engage when the pointer aligns with the selected gear position.
- Move the selector lever to *park*. The parking pawl should freely engage to lock the transmission, and the lever lock should freely enter the gate and be locked.
- Test to ensure that the starter operates in park and neutral but not in any other gear position.
- When checking adjustment, it is a good practice to also watch for any binding or hard movement, which indicates that the

shift cable or rod is dirty, rusty, or beginning to fail. Also check for any vertical movement, excessive lever slide, or sloppy motion, indicating failure of the selector lever.

- If the vehicle is not starting in the proper positions (neutral or park), first check the manual linkage adjustment. If this adjustment is correct, then test the neutral safety switch for proper operation and replace as necessary.

For adjusting/replacing manual linkage

- Before adjusting or replacing the manual shift linkage, check the engine and transmission mounts and the linkage bushings and pivot points.
- Adjust the manual shift linkage when the gear range pointer is not pointing at the selected gear position or the vehicle does not move in the selected direction.
- Replace the linkage when it is rusty, worn, or beginning to fail.
- Engage the gear selector in *park*, making sure that the pawl has completely entered the park gate, before raising and safely supporting the vehicle.
- Locate the manual linkage and its adjustment mechanism. The adjustable portion may be a slot in the shift rod or cable, a swivel clamp, or a long, threaded portion using a bracket and two nuts.
- Before adjusting the linkage to the proper length, ensure that the park detent and parking pawl are completely engaged. Test this by trying to rotate the drive shaft; it should be securely locked.
- When tightening the clamping bolt or lever, make sure that the transmission lever or the shift rod does not move out of adjustment.
- After adjustment, always repeat the linkage check to ensure correct adjustment.

For inspecting throttle linkage and determining whether adjustment is needed

- TV linkage checks are normally made with the engine off, but if there are indications that the linkage binds only with the engine running, some of the checks should be repeated with the engine running.

- ☐ *With engine off*
    - Check to ensure that the throttle is closed against the idle-speed adjusting screw.
    - Check the cable or rod for any slack or free movement; there should be none.
    - Roll the throttle to WOT, and check the cable or rod for free or sloppy movement, binding, or sticking; the TV linkage should move to WOT and release freely and smoothly.
    - With the throttle at WOT, try moving the TV linkage farther; it should move only a very small amount before contacting its stop.
- ☐ *With engine running*
    - Always set the parking brake and shift the gear selector to *neutral.*
    - Pull the end of the TV cable or move the TV rod so that it moves through it travel, and then release it. During the linkage movement, check for free or sloppy movement, sticking, or binding; there should be none.
    - In many cases it is possible to drop the pan and note the position of the TV plunger relative to the throttle position. It should move directly with the throttle.
    - Move the throttle lever while watching the kickdown rod or cable, if used. If the rod (or cable) is locked in the full-throttle position, the transmission will be slow to upshift.

- The most exact check for proper TV linkage adjustment is made using a pressure gauge installed in the transmission. This procedure is outlined in Job Sheet 2, Unit 2.

For adjusting/replacing throttle linkage

- Like the manual shift linkage, all TV linkage has an adjustment built into it, but there is little standardization among manufacturers: the adjustment mechanism may be a sliding swivel, snap lock, or self-adjusting slider with lock tabs.

- Replace the linkage when it is rusty, worn, or beginning to fail.

- After adjustment, always repeat the linkage check to ensure correct adjustment.

  ☑ **NOTE:** The correct adjustment of the linkage may result in a misaligned quadrant pointer. The customer should be made aware that realigning the pointer will require additional labor.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Other equipment and supplies as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

Functional Math
- Make measurements

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Consulted the service manual.	____	____
2. Safely raised and supported the vehicle.	____	____
3. Placed the transmission lever in *park*.	____	____
4. Locked the drive shaft by disconnecting the shift linkage and placing the transmission linkage in the gear specified by the manufacturer.	____	____
5. Inspected and adjusted or replaced manual shift linkage, TV linkage, kickdown linkage, and neutral safety switch as applicable.	____	____
6. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See the Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications: transmission locks in *park*.	4	3	2	1
Product includes proper components/ materials: linkages and switch replaced as necessary with appropriate components for vehicle.	4	3	2	1
Product appearance meets performance requirements: ☐ Smooth, timely shifts according to specifications ☐ No over-revving ☐ Engine starts only in *neutral* or *park*	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY	
	4 **Skilled** — Can perform job with no additional training
	3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
	2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
	1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 4

SERVICING HYDRAULIC SYSTEM COMPONENTS

Name ______________________________

OBJECTIVE 19 **Inspect and replace vacuum modulator, lines, and hoses.**

INTRODUCTION

Many transmissions use a vacuum modulator to control transmission throttle pressure and shift feel. The vacuum modulator uses the manifold vacuum signal from the engine to adjust throttle, line, accumulator, or shift-valve pressure.

The vacuum modulator is located on the transmission. Because of its location and operation, the plastic and rubber materials inside the modulator tend to dry out. The diaphragm becomes brittle as a result of the heat, cold, and contaminants. Failure of a modulator is not unusual within 15,000 to 20,000 miles after installation. Because of this, many transmission specialists recommend checking the modulator at periodic intervals as a part of preventive maintenance. Modulator checks should include diaphragm leakage, vacuum supply, sleeve/stem alignment, spring pressure, and on-vehicle operation.

Some transmissions use adjustable modulators. If fluid pressure readings are *all* slightly high or low, the specialist may adjust the modulator to correct a particular shift condition. When the modulator is not adjustable, it is replaced.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Vacuum gauge
- Hand-operated vacuum pump
- 0- to 20-pound scale
- Extension made of a ⅜-inch rod, small bolt, or old modulator valve
- Special modulator wrench recommended by manufacturer for torquing modulator
- Other equipment and supplies as required by procedure
- Appropriate service manual

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PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

Functional Math
- Make measurements

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Test manifold vacuum. Yes No

1. Disconnect vacuum line from modulator port. ____ ____
2. Connect a vacuum gauge to the vacuum line. ____ ____
3. Start the engine. ____ ____
4. Check vacuum-gauge readings against the service manual for acceptable vacuum limits. ____ ____

☑ **NOTE:** The amount of vacuum varies according to altitude, but should generally be about 17 to 20 inches. The gauge should show a steady reading.

5. Accelerate the engine momentarily; vacuum gauge should show a rapid drop. ____ ____
6. Release the accelerator; vacuum gauge should recover to its idle reading. ____ ____
7. Check for plugged, restricted, leaking, or incorrectly connected vacuum line or plugged manifold or restricted exhaust system if vacuum-gauge reading does not change or if it changes very slowly during steps 5 and 6. ____ ____

PROCEDURE

Test dual-area diaphragm.

☑ **NOTE:** Test the manifold vacuum side of dual-area diaphragm as described above, and then test the EGR vacuum side as outlined below.

1. Disconnect EGR vacuum line from modulator, leaving EGR port open to atmospheric pressure. ____ ____
2. Connect a vacuum gauge to EGR vacuum line. ____ ____
3. Start the engine; gauge should show zero vacuum. ____ ____
4. Gradually increase engine speed. ____ ____

Yes No

5. Check for plugged, leaking or incorrectly routed vacuum lines if vacuum gauge still shows zero vacuum. ____ ____

☑ **NOTE:** Trapped vacuum can cause transmission burnout. When the vacuum hose becomes soft and draws closed under high vacuum, it leaves high vacuum between the closed area and the modulator. In this case, you could have a high vacuum reading at the modulator and a low vacuum signal coming from the engine to the trapped spot. Under hard acceleration, this condition causes slippage and eventual burnout.

PROCEDURE **Test for diaphragm leakage (hand-pump method).**

1. Disconnect vacuum line at modulator port. ____ ____
2. Connect hand vacuum pump to modulator port. ____ ____
3. Apply approximately 17 to 20 inches of vacuum to diaphragm, and close shutoff on pump. ____ ____
4. Replace modulator if it does not hold vacuum for at least 30 to 60 seconds. ____ ____

PROCEDURE **Test for dual-area diaphragm leakage.**

☑ **NOTE:** Both sides of the dual-area diaphragm can be checked for leakage with a hand pump as described above, or this type of diaphragm can be checked for leakage using a manifold vacuum as outlined below.

1. Tee a vacuum gauge into the manifold vacuum line to modulator. ____ ____
2. Start the engine; vacuum gauge should show a steady reading. ____ ____

		Yes	No
	3. Note reading, and switch manifold vacuum to modulator EGR port, leaving manifold vacuum port open to atmospheric pressure.	____	____
	4. Replace modulator if vacuum gauge reading changes when connected to modulator EGR port.	____	____
PROCEDURE	**Check modulator stem alignment.**		
	1. Remove modulator, following appropriate removal procedure below.	____	____
	2. Roll modulator across bench top.	____	____
	3. Replace modulator if there is stem wobble that prevents it from rolling in a smooth circle.	____	____
	☑ **NOTE:** A good modulator should not wobble up and down when rolled. Wobble indicates a bent stem that will probably bind or stick.		
PROCEDURE	**Check modulator spring pressure.**		
	1. Place modulator with stem end down on 0- to 20-pound scale.	____	____
	2. Use extension to push downward on modulator until extension starts to move inward and stem starts to contract into modulator sleeve.	____	____
	3. Check the scale reading; this will be the *minimum* spring pressure reading.	____	____
	4. Continue pressing down until extension stops and spring is fully contracted into modulator sleeve.	____	____
	5. Check the scale reading: this will be the *maximum* spring pressure.	____	____

Yes No

6. Check spring pressure readings against minimum and maximum pressures in shop manual for vehicle; if too strong or too weak, replace the modulator. ____ ____

PROCEDURE **Remove a screw-in vacuum modulator.**

1. Disconnect lines from the modulator vacuum port(s). ____ ____
2. Unscrew modular unit, using tool recommended in service manual as necessary for breaking seal without damaging modulator. ____ ____
3. Carefully withdraw control rod or valve from transmission case. ____ ____

PROCEDURE **Remove a push-in vacuum modulator.**

1. Disconnect lines from modulator vacuum port(s). ____ ____
2. Remove retaining bolt and bracket. ____ ____

⚠ **CAUTION:** Do not pry or bend the bracket. This can distort the modulator unit and damage the diaphragm inside.

---

3. Remove modulator from transmission case by pulling straight out. ____ ____
4. Carefully withdraw control rod or valve from transmission case. ____ ____

PROCEDURE **Replace a screw-in vacuum modulator.**

1. Install control rod or valve in transmission case. ____ ____
2. Thread modulator into case, and tighten to manufacturer's torque specifications with modulator wrench recommended by manufacturer. ____ ____

Yes No

3. Connect vacuum line(s) to modulator vacuum port(s) ____ ____

☑ **NOTE:** If installing a Ford dual-area diaphragm, make sure to connect the lines to the proper ports.

PROCEDURE

Replace a push-in vacuum modulator.

1. Install control rod or valve in transmission case. ____ ____
2. Insert modulator sleeve into case, working O-ring into bore carefully and pushing unit into case as far as it will go. ____ ____
3. Position retainer bracket and install attaching bolt. ____ ____
4. Torque attaching bolt to manufacturer's specifications. ____ ____
5. Connect vacuum line(s) to modulator vacuum port(s). ____ ____

☑ **NOTE:** If installing a Ford dual-area diaphragm, make sure to connect the lines to the proper ports.

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 5

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Name ____

OBJECTIVE 20

Inspect and replace governor assembly.

INTRODUCTION

The governor senses road speed (transmission output shaft speed) to help control gear shifting. The vacuum modulator and governor work together to determine shift points. The governor gear is usually meshed with a gear on the transmission output shaft. Whenever the vehicle and output shaft are moving, the governor's centrifugal weights rotate.

When the output shaft and weights spin slowly, the weights are held in by reaction pressure. This causes low pressure output, and the transmission remains in a low gear ratio. As shaft speed increases, the weights are thrown out further, and governor pressure increases. This moves the shift valve and causes the transmission to shift to a higher gear.

In most Ford and Chrysler rear-wheel drive transmissions, the governor is mounted on the output shaft. In all GM rear-wheel drive transmissions, the governor fits into a case bore and is driven by a gear in the transmission output shaft.

In recent automatic transmissions, some, or all, of the governor's functions are replaced by electrically controlled solenoid valves.

Guidelines

- The governor is serviced as an assembly. Repair or replace the governor assembly if any problems are found.
- Do not let the output shaft slide through the case when the governor is removed; otherwise you will damage the case.
- Remove the governor drive ball (if the governor is so equipped) with a magnet, so that the ball will not fall free.
- If necessary, tap the governor assembly with a plastic-tipped hammer to loosen it from the shaft.
- Wash the governor in parts-cleaning solution and blow out all passages.

- Inspect governor according to manufacturer's specifications. Look for the following defects:

  ☐ Scored or rusted valve bore

  ☐ Scored, nicked, or rusted spool valve

  ☐ Damaged or plugged governor screen

  ☑ **NOTE:** The screen may be located in the case or in the main valve body.

  ☐ Damaged or distorted mating surfaces

  ☐ Binding, sticking, or damaged weights

  ☑ **NOTE:** The weights and valve should move freely up and down.

  ☐ Broken or distorted springs

  ☐ Cut, distorted, or loose seals

  ☐ Broken snap-rings and damaged snap-ring grooves

  ☐ Plugged or restricted fluid passages in the case or output shaft

  ☐ Damaged or excessively loose driven gear

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Other equipment and supplies as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Yes No

Process Evaluation Criteria:

1. Consulted the service manual. ____ ____

Functional Reading
- Follow written instructions
- Use content area vocabulary

Functional Math
- Make measurements

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
2. Followed all procedures in order as listed in the service manual.	____	____
3. Replaced all seals and O-rings with new ones.	____	____
4. Marked the drive shaft before removal.	____	____
5. If extension housing was removed, replaced the extension housing gasket with a new one.	____	____
6. Checked vehicle shift speeds.	____	____
7. Returned transmission fluid level to full mark.	____	____
8. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1

Product includes proper components/materials: replacement seals, O-rings, and gasket appropriate for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements: ☐ No deviations from manufacturer's specifications in upshift and downshift speeds. ☐ No fluid leaks. ☐ Fluid level at full mark.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 6

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Name ______________________________

OBJECTIVE 21 **Remove and repair or replace valve body.**

INTRODUCTION

Because of its appearance and functions, the valve body is often called the automatic transmission's brain. Its purposes are to sense the load on the vehicle's engine and drivetrain, and to sense the operator's driving requirements.

Valve bodies are made of aluminum or cast iron. Internally they contain many fluid passages called worm tracks. Off the worm tracks are many precisely machined holes to accommodate the valves generally used in automatic transmissions: check ball, poppet, and—most commonly—spool. The purpose of the valves in the valve body is to regulate fluid flow. Valve bodies also contain springs, pistons, accumulators, and servos.

Some valve bodies are bolted directly to the transmission housing so that the valve body becomes part of the housing assembly.

Guidelines

- Automatic transmissions and transaxles can vary in small ways internally from each other or from exploded views. Always keep subassembly parts grouped together in a logical sequence. This will help you find the right parts and will greatly aid in reassembly.

- When removing the valve body, be sure to release it slowly and to catch any springs or parts that may fall free.

- Note the installed position of all check balls to ensure that they are reinstalled in the same locations.

- The valve body should be disassembled and inspected on a clean, lint-free surface. Remove each valve, inspect it for wear or scoring, and place it in its designated place on the towel or in the cleaning basket.

- When all valves have been removed, clean the valve body with a cleaning solution and air dry, or dry with compressed air.

- After reinstalling each valve, make sure that it moves freely in its bore.
- Do not use gasket cement when reinstalling the valve body.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Other equipment and supplies as required by procedure

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

Functional Math
- Make measurements

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

☑ **NOTE:** Refer to the appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Consulted the service manual.	___	___
2. Safely raised and supported vehicle.	___	___
3. Properly drained fluid from transmission.	___	___
4. Removed oil pan or valve body cover.	___	___
5. Removed valve body attaching bolts and valve body.	___	___
6. Removed all valve body parts from valve body and placed in cleaning basket or on clean, lint-free towels.	___	___
7. Cleaned all parts and air dried or dried with compressed air.	___	___
8. Used assembly lubricant to retain check balls when reinstalling valve body.	___	___
9. Did not use gasket cement when reinstalling valve body.	___	___
10. Tightened body attaching bolts to manufacturer's specifications.	___	___

	Yes	No
11. Filled vehicle with proper amount and type of automatic transmission fluid.	____	____
12. Test drove vehicle and checked for leaks.	____	____
13. Returned vehicle to service.	____	____
14. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications: valves move freely in their bores.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements: valve edges not rounded from cleaning.	4	3	2	1

Product appearance meets industry standards: all valves tarnish-free.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 7

SERVICING HYDRAULIC SYSTEM COMPONENTS

Name ______________________________

OBJECTIVE 22 **Remove and repair or replace a servo assembly.**

INTRODUCTION

A servo is a piston and cylinder assembly that applies and releases a band around a drum. The servo operates when hydraulic pressure is applied to the large surface area of its piston, multiplying the hydraulic force of the system. This higher force is needed because the pressure necessary to apply the band to its drum is greater than system pressure.

Servos take different forms in different vehicles. They may be cast into the transmission case as integral assemblies, or they may be bolted to the case as separate assemblies using levers to transmit action.

The item of greatest wear on a servo is its seal.

Guidelines

- Automatic transmissions and transaxles can vary in small ways internally. Always keep subassembly parts grouped together in a logical sequence. This will help you find the right parts and will greatly aid in reassembly.
- The servo assembly is under spring tension. Use extreme care that the cover and servo parts do not fly loose when removed. Always wear safety glasses.
- Clean servo parts with appropriate cleaning fluid and allow to air dry, or dry with compressed air.
- Always inspect the servo piston bore for scoring or damage. If bore wall is scored, replace the transmission case.
- Check the piston and piston rod for nicks, scoring, and burrs.
- Replace any springs that are damaged, collapsed, or distorted.

- Check the mating surfaces between the piston and bore wall for nicks, scoring, or damage. Make sure that the piston moves freely in the bore.
- Remove bore glazing with 400-grit emory cloth.
- Check fluid passages for restrictions; remove any debris and clean passages thoroughly.
- Remove the seals and replace them with new ones. Some piston and seal assemblies must be replaced as units.
- Check apply pin length against service manual specifications.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Other equipment and supplies as required by procedure

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

Functional Math
- Make measurements

☞ **NOTE:** Refer to the appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Consulted appropriate service manual.	____	____
2. Safely raised and supported vehicle.	____	____
3. Removed servo assembly safely.	____	____
4. Inspected all parts of servo for wear and damage; replaced worn or damaged parts.	____	____
5. Cleaned servo bore.	____	____
6. Removed debris from fluid passages.	____	____
7. Checked for leaks.	____	____
8. Replaced seals.	____	____
9. Checked length of apply pin against service manual specifications.	____	____

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

10. Followed all safety procedures. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 8

SERVICING HYDRAULIC SYSTEM COMPONENTS

2

Name ____

OBJECTIVE 23

Inspect an accumulator.

INTRODUCTION

Cleaning and inspecting servos and accumulators are similar procedures. Accumulator parts should be cleaned with appropriate cleaning fluid and allowed to air dry. All seals should be replaced with new ones. Some accumulator piston and seal assemblies must be replaced as a unit. Use the following procedure to inspect an accumulator.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Clean, fresh cleaning fluid
- Scotch Brite®
- Replacement parts as appropriate
- Other equipment and supplies as required by procedure

PROCEDURE

Research and Reference
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Use content area vocabulary

Yes No

1. Inspect the transmission case bore for scoring and damage. ____ ____

   ☑ **NOTE:** If the transmission bore walls are scored, the transmission case must be replaced.

2. Inspect the piston and piston rod for nicks, scoring, burrs, or worn areas; replace if damaged. ____ ____

3. Test the spring for strong, positive action; replace if weak. ____ ____

Functional Math
- Make measurements

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

4. Inspect the spring for damage, collapse, or distortion; replace if any of these conditions is found. ____ ____

5. Inspect the mating surfaces between the piston and bore wall; surfaces should be smooth and not restrict piston movement. ____ ____

6. Cross-hatch bore with Scotch Brite to help provide seal lubrication. ____ ____

7. Check fluid passages for restrictions. ____ ____

8. Remove any debris from fluid passages, and clean the passages thoroughly with cleaning fluid. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1

Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
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1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

OBJECTIVE SHEET

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

3

INTRODUCTION

Many of today's vehicles are rear-wheel drive—the transmission mounted behind the engine, and a drive shaft transferring power to the rear axle and driving wheels. While the trend today is toward front-wheel drive vehicles, rear-wheel drive vehicles are still being manufactured, and the automatic-transmission specialist will certainly service these vehicles and those rear-wheel drive vehicles still on the road. Properly serviced and maintained by an automotive specialist skilled in rear-wheel drive transmission service, automatic transmissions in rear-wheel drive vehicles will operate dependably and properly for many miles.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information

Research and Reference
- Select useful resources

Functional Reading Skills
- Interpret graphics and symbols

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS	
PREREADING:	Read the material in your textbook about rear-wheel drive transmissions.
WRITING:	Write a paragraph or two in which you discuss the advantages and disadvantages of RWD as compared to FWD.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Answer questions about the characteristics of rear-wheel drive automatic transmissions.
2. Label the parts of a typical console shift-linkage arrangement on a rear-wheel drive transmission.
3. Label the parts of a typical column shift linkage on a rear-wheel drive transmission.
4. Describe the functions of various types of automatic transmission linkages and controls.
5. List indicators of improper linkage adjustment.
6. Name terms associated with replacement seals.
7. Label bushings, thrust bearings, and thrust washers typically used on modern transmissions.
8. List reasons why a specified amount of endplay is necessary in automatic transmissions.
9. State reasons for endplay adjustment.
10. Remove a transmission. (Job Sheet 1)
11. Disassemble and clean a transmission. (Job Sheet 2)
12. Replace external seals and gaskets. (Job Sheet 3)

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

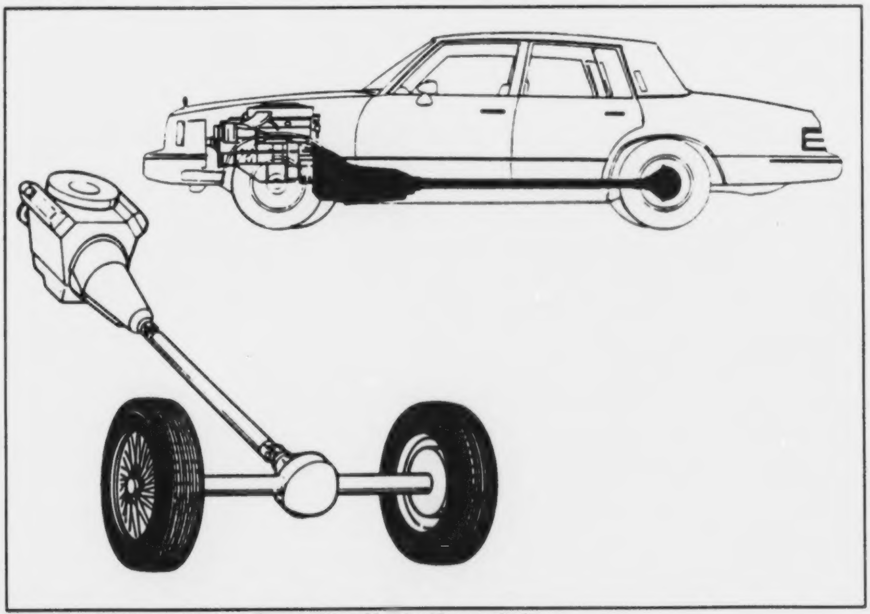
OBJECTIVE 1

Required Activities/ Resources in Instructor's Guide

Answer questions about the characteristics of rear-wheel drive automatic transmissions.

- RWD vehicles use a conventional transmission.
- In RWD vehicles, the drive shaft connects the transmission to the rear axle.
- The final drive/differential assembly is a separate unit in the rear of the vehicle and is linked to the transmission by the drive shaft.
- The RWD vehicle is pushed when the driveline transmits torque from the transmission output shaft to the driving wheels.
- RWD design creates more stable movement than front-wheel drive vehicles because of more even weight distribution from front to rear of vehicle.

FIGURE 1



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OBJECTIVE 2

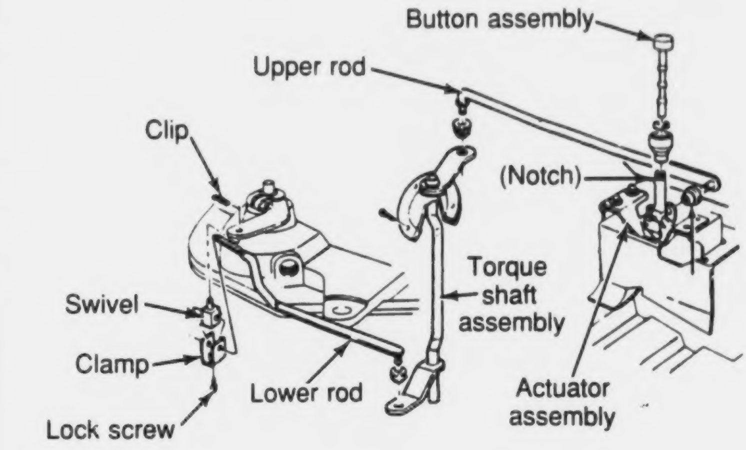
Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Label the parts of a typical console shift-linkage arrangement on a rear-wheel drive transmission.

WORDS YOU SHOULD KNOW	
linkage	a series of rods or links that transmit motion
actuate	to put into mechanical action or motion
swivel	to turn or pivot freely

FIGURE 2



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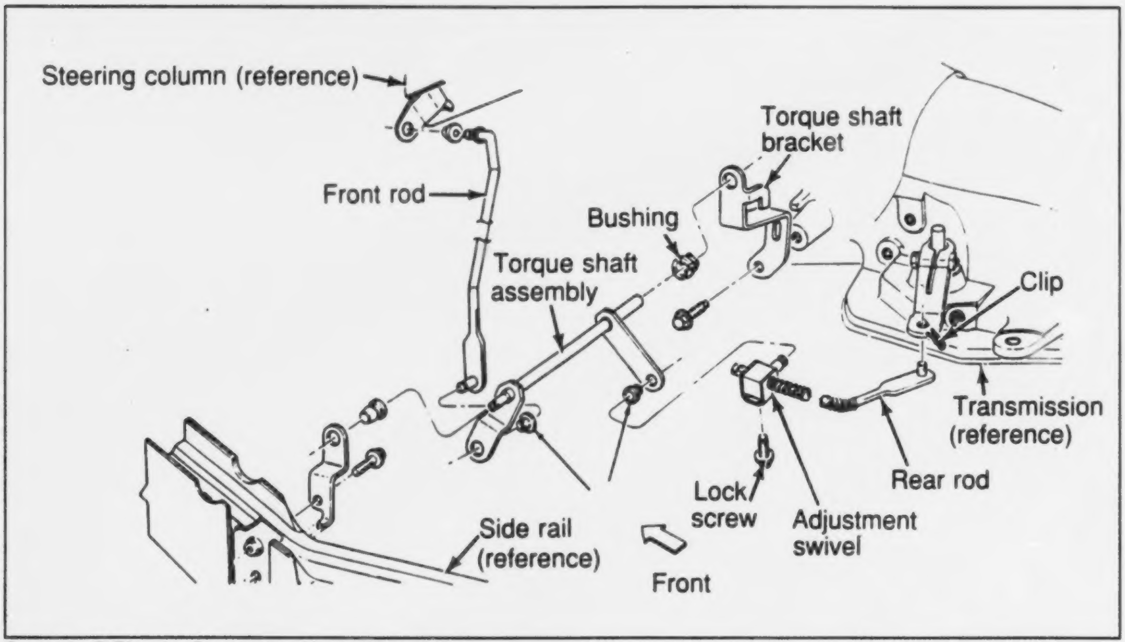
OBJECTIVE 3

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Label the parts of a typical column shift linkage on a rear-wheel drive transmission.

FIGURE 3



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OBJECTIVE 4

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Describe the functions of various types of automatic transmission linkages and controls.

WORDS YOU SHOULD KNOW	
kickdown	system in automatic transmission that produces a downshift when the accelerator is pushed abruptly to the floorboard (as for passing)
throttle	a plate in the carburetor that allows the driver to control engine speed by varying the amount of air/fuel mixture that enters the engine
throttle valve	a valve in the transmission that responds to an engine load signal by means of cables or linkage connected to the engine

WORDS YOU SHOULD KNOW	
WOT	wide-open throttle position with the accelerator pressed to the floorboard; also called *full throttle*

- **throttle valve linkage (TV linkage)** — signals engine load to the transmission

  ☑ **NOTE:** The throttle valve linkage may be a solid rod or cable.

- **manual shift linkage** — transmits driver's vehicle direction and gear selection commands to the manual control valve

  ☑ **NOTE:** The manual shift linkage is sometimes called *gearshift linkage, manual linkage, or shift linkage* and may be a solid rod or cable.

- **kickdown linkage** — permits driver to obtain a downshift

- **neutral safety switch** — prevents engine from cranking in any gear but neutral or park; on transmissions equipped with electronically controlled converter clutches, it also sends a signal to the computer and may also control the reverse light switch

  ☑ **NOTE:** The neutral safety switch is sometimes called a *neutral start switch.* While the neutral safety switch is not usually thought of as a linkage adjustment, it should not be overlooked. *Starting in a drive range can be dangerous.*

- **vacuum regulator valve** — controls shift points by sending vacuum signal to the transmission to produce throttle valve pressure signal on some vehicles equipped with a diesel engine

  ☑ **NOTE:** Most diesels need a separate vacuum pump to supply the various systems with vacuum. The vacuum regulator valve is usually mounted on the injection pump.

OBJECTIVE 5

List indicators of improper linkage adjustment.

Optional Activities/ Resources in Instructor's Guide

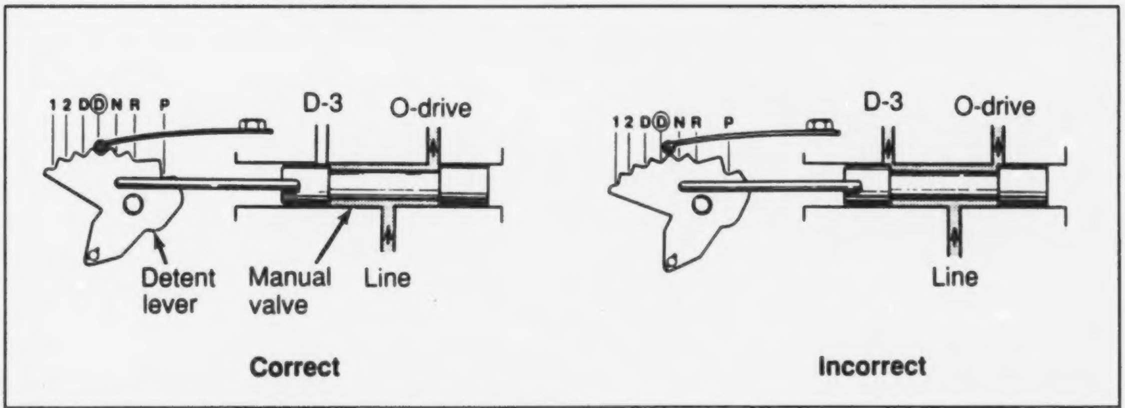
Required Activities/ Resources in Instructor's Guide

WORDS YOU SHOULD KNOW	
gate stop	guide containing a groove or notch that holds the gear selector lever in position and prevents slippage

- **Throttle valve linkage**
  - Shift points too high
    - Overly sensitive downshifts
    - Excessively firm, harsh shifts
  - Shift points too low
    - Late or no downshifts
    - Soft, mushy shifts
  - Erratic, irregular shifts (sticky or binding linkage)
  - Clutch band slippage
- **Manual shift linkage**
  - Misdirected oil pressure

    ☑ **NOTE:** Oil pressure is misdirected when a misadjusted manual shift linkage places the manual valve in the wrong position and the valve leaks oil pressure into incorrect passages. (Figure 4)

FIGURE 4



Correct

Incorrect

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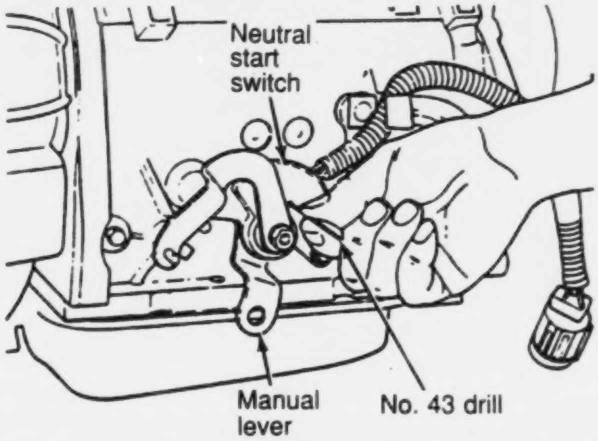
  - Possible lockup of wrong components
  - Creep from partially applied clutch
  - Overheating and burnout
  - Transmission detents misaligned relative to gear-shift pointer
  - Selector-lever slippage

    ☑ **NOTE:** The transmission may shift into park without the gear selector entering the locking gate stop, thus allowing the lever to slip out of park and into reverse gear.

- **Kickdown linkage**
  - Over-revving
  - Engine failure (due to over-revving)
  - No kickdown
- **Neutral safety switch**
  - Starter engages in drive or reverse position

    ☑ **NOTE:** On some transmissions, the neutral safety switch is always positioned correctly relative to the manual valve because it is activated by a manual lever quadrant inside the transmission. Improper starter operation on these vehicles indicates a misadjusted manual shift linkage. Other transmissions mount the neutral safety switch outside the transmission—on the outside of the case or at the shift lever—and these switches have a separate adjustment. (Figure 5)

FIGURE 5



Adjustment of neutral safety switch mounted on a Ford rear-wheel drive vehicle

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OBJECTIVE 6

Required Activities/ Resources in Instructor's Guide

Name terms associated with replacement seals.

- **butt-joint** — pertains to the angle at which a Teflon® or metal seal is cut; the seal is split *straight* across its face
- **gasket** — flat seal, usually of paper, cork, rubber, plastic, or synthetic materials, placed between two parts with irregular surfaces to ensure proper sealing
- **gasket compressibility** — ability of a gasket to conform to surface irregularities
- **hard gasket** — gasket, such as a common plain paper gasket, that can be compressed less than 20 percent
- **hook joint** — a metal ring with ends connected by a hook
- **metal-clad seal** — lip-type seal with a rigid exterior housing; the flexible inner lip is bonded to the metal

  ☑ **NOTE:** Most metal-clad seals have to be driven into the bore in which they fit.

- **O-ring** — round ring that is pressed into grooves to provide sealing action

430

- **RTV sealant** — room-temperature vulcanizing sealant that sets up in the presence of air; sometimes used in place of a gasket to seal covers attached to engine or transmission
- **scarf-cut** — pertains to the angle at which a Teflon® seal is cut; the seal is split *diagonally* across its face
- **seal** — device that prevents oil leakage around a moving part
- **soft gasket** — gasket that can be compressed more than 20 percent, such as a cork/rubber composition gasket

OBJECTIVE 7

Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

Label bushings, thrust bearings, and thrust washers typically used on modern transmissions.

WORDS YOU SHOULD KNOW	
axial play	back-and-forth movement of a gear, gearset, hub, or drum along, or parallel to, the axis of a shaft; also called *end thrust* or *endplay*
endplay	the total amount of axial play in an automatic transmission
	☑ **NOTE:** A specified amount of endplay is necessary in all automatic transmissions.
journal	machined surface on a shaft on which the bushing rides
radial play	side-to-side movement of a gear, gearset, hub, or drum on a shaft; also called *side thrust* or *side play*
	☑ **NOTE:** Because automatic transmissions use planetary gears that are continuously meshed, there is much less radial play than there is in a manual transmission.
selective washers	thrust washers of varying thicknesses which adjust endplay

Your instructor will display bushings, thrust bearings, and thrust washers typically used on modern transmissions. You must be able to label ten (10) of the items displayed. Write the names of the items displayed in the blanks provided.

____

____

____

____

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OBJECTIVE 8

Optional Activities/
Resources in
Instructor's Guide

List reasons why a specified amount of endplay is necessary in automatic transmissions.

- To allow metal parts to expand without binding as the transmission reaches operating temperatures
- To keep sealing rings in proper location and prevent bearing damage or failure
- To retain lubrication oil

OBJECTIVE 9

Required Activities/
Resources in
Instructor's Guide

State reasons for endplay adjustment.

- To prevent loss of hydraulic pressure when the transmission is cold
- To prevent the transmission from seizing up when the transmission warms up

OBJECTIVES 10-12

Complete Job Sheets 1-3.

JOB SHEET 1

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

3

Name ____

OBJECTIVE 10

Remove a transmission.

INTRODUCTION

There is no single, detailed procedure that the specialist can use to remove *all* transmissions. Body style, model year, and the engine/transmission combination make each job a little different. Describing the exact removal procedures for each particular transmission is not possible here, nor is it necessary. Removing an automatic transmission is not difficult if the specialist uses common sense and good judgment; has at hand the necessary service manual, tools, and equipment; and follows a logical procedure. The specialist should be able to adapt the following procedure to work with any automatic transmission.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Large drain pan
- Tilting-base transmission jack
- C-clamp
- Safety strap or chain
- Hot-solution parts-cleaning tank
- Shop air
- Shop towels
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Yes No

1. Open hood and think through job, trying to visualize what will happen when you lower the back of the engine for transmission removal.

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Transfer knowledge/ training to new situations

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

- Check radiator hoses, fan, and other parts at *front of engine* to make sure that they will not interfere or be damaged during removal process. ____ ____
- Check parts at *back of engine* to ensure that there is clearance at firewall. ____ ____

2. Remove distributor cap and rotor from V-8 engines having a rear-mounted distributor. ____ ____

3. Disconnect battery ground cable. ____ ____

4. If it is secured at upper end, remove fasteners from transmission dipstick filler tube. ____ ____

   ☑ **NOTE:** This will facilitate later removal of filler tube from vehicle.

5. Leaving hood open, safely raise vehicle to proper working height on a hoist. ____ ____

   ☑ **NOTE:** By leaving the hood open, you can prevent damage caused by an engine-mounted part moving enough to strike the hood. An open hood also allows more light to fall on your work.

6. Place a large drain pan under converter and transmission oil pan. ____ ____

7. Drain converter and transmission. ____ ____

   ☑ **NOTE:** If necessary, refer to Unit 2 and your shop service manual for these procedures.

8. When draining is complete, use several bolts to replace oil pan. ____ ____

   ☑ **NOTE:** This will provide a surface for the transmission jack.

9. Disconnect electrical leads from starter motor or solenoid, if applicable. ____ ____

	Yes	No
10. If required, unbolt and remove the starter motor.	____	____
11. Lower exhaust system as necessary for working room.	____	____
12. Disconnect vacuum line at modulator.	____	____
13. Remove any clips holding vacuum line to housing.	____	____
14. Remove transmission fluid cooler lines.		
• Remove any clamps or clips used to hold cooler lines in place.	____	____
• Place drain pan under cooler lines.	____	____
• Using two wrenches—one to hold fitting and one to loosen tubing nut—carefully disconnect lines.	____	____
☑ **NOTE:** Using two wrenches in this manner prevents damage to the cooler line and fitting.		
15. Plug cooler lines to keep out dirt.	____	____
16. Disconnect all mechanical linkages, and move to one side to ensure that they will clear the transmission when you remove it.	____	____
☑ **NOTE:** Note the location of the linkage parts so that you can reinstall them correctly. If nylon grommets are used as retainers, you may have to pry the linkage apart and cut away the old grommet.		
17. Check to see if there are any more pivots on or near bellhousing.	____	____
18. Disconnect speedometer cable from transmission and move it out of the way.	____	____
19. Disconnect all electrical wiring to such devices as backup lamp switch, spark timing control switch, and neutral safety switch.	____	____

Yes No

20. Trace wiring harnesses to unfasten any mounting clips. ____ ____

⚠ **CAUTION:** All wiring must be completely free of the transmission case.

---

21. Remove transmission dipstick filler tube by removing remaining bolts or by pulling it straight out of its location, taking care not to bend or twist it. ____ ____

22. Remove drive shaft.

- Make an index mark across rear universal joint and its companion flange, then disconnect drive shaft from universal joint. ____ ____
- Remove rear yoke or companion flange bolts, placing them and their nuts in a small container so that you do not lose them. ____ ____
- Hold the bearing and universal-joint cross in place as you separate shaft from rear yoke. ____ ____
- Secure bearing caps to cross with tape or wire. ____ ____
- Lower rear of drive shaft a few inches. ____ ____
- Slip drive shaft sliding yoke from transmission extension housing. ____ ____
- Plug extension housing with a seal driver to prevent transmission fluid from leaking onto floor. ____ ____

Yes No

23. Position transmission jack.

- Place transmission jack squarely under transmission oil pan. ____ ____
- Adjust height of jack—tilting base plate to fit oil pan—and tighten adjusting screws. ____ ____
- Move each corner of base plate into position, and tighten retaining bolts. ____ ____

  ☑ **NOTE:** When properly adjusted, the transmission oil pan should fit *into* the jack base plate.

- Secure transmission to jack with a safety chain or strap. ____ ____
- Raise jack slightly to relieve weight on rear transmission mount. ____ ____

24. Unbolt rear transmission mount from the crossmember, using an extra-long socket or extension to reach all bolts easily. ____ ____

25. Unbolt and remove the transmission crossmember. ____ ____

26. Mark relationship of torque converter and flexplate or flywheel so that you can reinstall converter in exact same location to maintain engine and converter balance. ____ ____

⚠ **CAUTION:** Do not leave the converter attached to the engine while removing the transmission. This could damage the input shaft, the converter, and the pump.

---

27. Remove nuts or bolts that attach converter to flexplate or flywheel.

- Rotate engine to gain access to all bolts and nuts. ____ ____

	Yes	No
28. Make one final check to ensure that no components are left that will interfere with transmission removal.	____	____
29. Pull out transmission.		
• Support rear of engine on a separate jack to prevent it from dropping as bolts are removed.	____	____
• Remove lower bolts that attach bellhousing to rear of engine.	____	____
• Lower jack as necessary, and remove upper bolt that attaches bellhousing to rear of engine.	____	____
30. Slowly move transmission jack and transmission to the rear, grasping torque converter to make sure that it moves as a unit with transmission.	____	____
☑ **NOTE:** If holding the torque converter with your hand is awkward, attach a small C-clamp to the edge of the bellhousing to hold it in place.		
31. When the transmission is moved back away from the engine, lower it from the vehicle.	____	____
32. Inspect converter flexplate assembly for cracks around the bolt holes and for tooth wear.	____	____
☑ **NOTE:** The flexplate must be replaced if any crack or tooth wear is found.		
33. Carefully remove converter from front of transmission, pulling it straight out to prevent scoring front pump or seal.	____	____
34. Place converter flat on an unused part of workbench.	____	____
35. Transfer transmission to a support stand or place it on a clean workbench if a stand is not available.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY	4 **Skilled** — Can perform job with no additional training 3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required 2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill 1 **Unskilled** — Is familiar with process, but is unable to perform job
EVALUATOR'S COMMENTS	______________________________ ______________________________ ______________________________

JOB SHEET 2

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

Name ______________________________

OBJECTIVE 11 **Disassemble and clean a transmission.**

INTRODUCTION

After the transmission has been removed from the vehicle, it is a good practice to clean the exterior before disassembly. Before you do any exterior cleaning, however, make sure that you remove the torque converter and dipstick tube. Plug the hole where the tube was to prevent cleaning solution from entering the case. Also remove any external electrical wires or devices that could be damaged during cleaning.

Disassemble the transmission in an orderly and sequential manner, arranging all parts in their order of removal and placing small parts on a clean shop towel in an area where they will not be underfoot or in the way.

Guidelines

- Remove all gaskets, O-rings, seals, and sealing rings before you attempt to clean any part.
- *Do not* throw old gaskets and seals away. Keep them with the component from which they were removed. Old gaskets and seals—particularly valve-body gaskets—will be needed later for comparison with the new gaskets and seals.

CAUTION: Many overhaul kits come with steel sealing rings to replace the Teflon® ones. *Make sure* that you check the steel replacement in the groove carefully. In some cases, the depth of the Teflon® ring groove is less than that of one for a steel groove. Even though the steel replacement will fit the bore, if the groove is not deep enough, the ring cannot compress enough when installed. As a result, the steel ring will break as the parts are assembled.

- Use a hot-solution parts-cleaning tank to clean all "hard parts" that are coated with varnish.
- Air-dry cleaned parts only. Do not use shop towels; they will leave lint that will clog the filter.

CAUTION: To prevent eye damage, always wear eye protection when air-drying parts.

- Coat all iron or steel parts with clean ATF to prevent rusting.
- Make sure that case and all attaching parts are thoroughly cleaned in a hot-solution parts-cleaning tank.
- Keep all internal parts in order of removal to prevent problems during reassembly. You cannot always rely on a typical illustration to show exactly the same transmission on which you were working.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Hot-solution parts-cleaning tank
- Shop air
- Shop towels
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Transfer knowledge/training to new situations

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

☑ **NOTE:** Refer to the appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Consulted appropriate service manual.	____	____
2. Before cleaning, removed torque converter and dipstick tube and plugged the hole where the tube was located.	____	____
3. Removed any external electrical wires or devices that could be damaged during the cleaning process.	____	____
4. Removed all gaskets, O-rings, seals, and sealing rings before cleaning any part.	____	____
5. Kept old gaskets and seals.	____	____
6. Kept old gaskets and seals with the component from which they were removed.	____	____
7. Read operating instructions for parts cleaning machine.	____	____
8. Used an approved cleaning solution.	____	____
9. Disassembled the transmission in an orderly and sequential manner, arranging all parts in their order of removal.	____	____
10. Kept work area clean, and kept all parts—particularly the valve body—clean and free of lint.	____	____
11. Wore appropriate safety equipment and clothing.	____	____
12. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

JOB SHEET 3

SERVICING REAR-WHEEL DRIVE TRANSMISSIONS

3

Name ______________________________

OBJECTIVE 12

Replace external seals and gaskets.

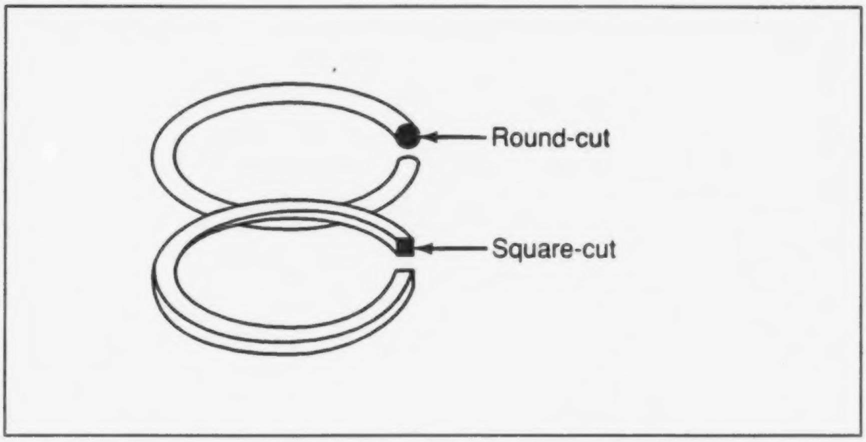
INTRODUCTION

Most transmissions have many covers bolted to them and shafts running through them. Some type of seal is necessary to prevent leakage at each place. The type of seal ranges from a flat gasket to an O-ring to a metal-clad seal. Anyone can take one seal off and replace it with another. The dedicated specialist will take the time to also see that the new seal fits properly.

Guidelines

- **Round- and square-cut O-ring seals** (Figure 1)

FIGURE 1



☐ Place seal in bore in which it rides, and observe the fit.

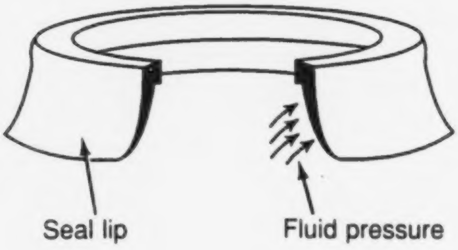
✓ **NOTE:** Clearance between the outer edge of seal and bore should not exceed manufacturer's specifications.

☐ Check for proper thickness (one seal at a time) by placing seal in piston groove, pulling on piston, and noting amount of drag.

- **Lip-type seals**

  ☑ **NOTE:** Check only *one* seal at a time. Ensure that the lip always faces fluid so that fluid will force it against the bore. (Figure 2)

FIGURE 2



☐ Place seal in piston groove, lubricate seal, and insert piston in bore.

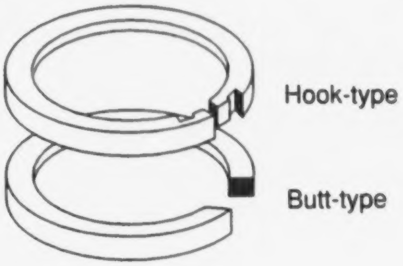
☐ Turn bore upside down while holding the piston.

☐ Let go of piston, and note drag when piston falls out.

☑ **NOTE:** You should feel a slight resistance (drag). If no drag is felt, the seal is too small for the bore. Clearance between the seal face and the bore should be very close.

- **Hook-type (locking) and butt-type metal sealing rings** (Figure 3)

FIGURE 3



- ☐ Check the bore for wear.

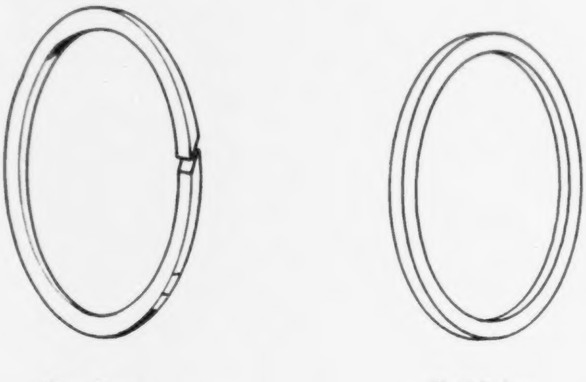
- ☐ Insert the seal in an unworn bore and measure clearance (butt-type) or gap (hook-type) with a feeler gauge.

  ☑ **NOTE:** Clearance should meet manufacturer's specifications.

- **Solid and scarf-cut Teflon® sealing rings** (Figure 4)

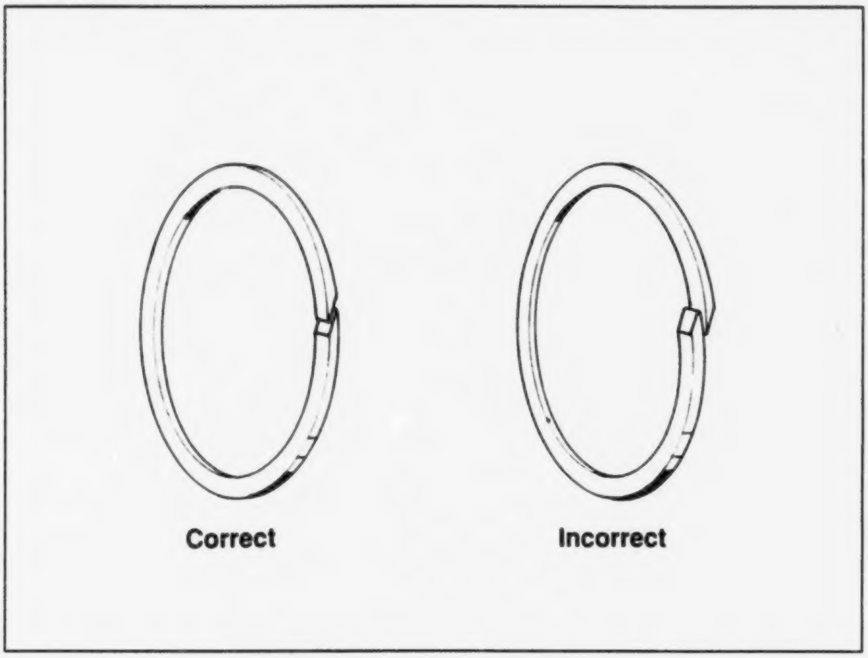
  ☑ **NOTE:** Because Teflon® is soft, metal particles easily become embedded in it. When these particles are embedded in the ring face, they act as an abrasive and wear grooves in the bore. When they are embedded in the sides of the ring, sealing capabilities are lost. The ring can also absorb so much metal that it will stick to the ring groove in the bore.

FIGURE 4



- ☐ Install new ring on shaft with special installing sleeve, first making sure that scarf-cut ends are properly aligned. (Figure 5)

FIGURE 5



☐ Tap sizing tool over seal to reduce seal diameter.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Compressed air
- Manufacturer's recommended lubricant
- Manufacturer's recommended transmission fluid
- Appropriate replacement seals
- Special seal removers and installers as necessary
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Transfer knowledge/training to new situations

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Remove external gaskets and seals (covers with flat gaskets or O-rings). Yes No

1. Raise vehicle on hoist. ____ ____
2. Remove all dirt from around mating surfaces. ____ ____

⚠ **CAUTION:** If you blow off the dirt with compressed air, wear eye protection to prevent eye injury.

---

3. Place drain pan under cover to be removed. ____ ____
4. Loosen bolts or clips that hold cover in place. ____ ____

⚠ **CAUTION:** Some accumulator and servo covers contain a strong spring. Be careful that it does not fly off and hit you.

---

5. Remove cover, gasket, and/or O-ring. ____ ____
6. Place gaskets and O-rings with the component from which they were removed. ____ ____
7. Scrape old gasket material from both mating surfaces, taking care not to scratch the surfaces. ____ ____
8. Clean cover with solvent and blow dry. ____ ____

⚠ **CAUTION:** Wear eye protection to prevent eye injury.

---

9. Check new seal against removed seal for proper type, size, and thickness. ____ ____
10. Check new seal for fit. ____ ____
11. Install cover, tightening bolts to manufacturer's torque specifications. ____ ____
12. Lower vehicle, and replace any lost fluid. ____ ____

PROCEDURE

Remove external gaskets and seals (shafts with metal-clad seals). Yes No

1. Raise vehicle on hoist. ____ ____
2. Remove all dirt from around seal. ____ ____

⚠ **CAUTION:** Wear eye protection to prevent eye injury.

---

3. Place drain pan under seal to be replaced. ____ ____
4. Remove linkage from shaft. ____ ____
5. Carefully pry old seal out of housing, taking care not to nick housing surface. ____ ____
6. Place seal with component from which it was removed. ____ ____
7. Clean area where new seal will be installed. ____ ____
8. Check new seal against removed seal for proper type, size, and thickness. ____ ____
9. Check new seal for fit. ____ ____
10. Install new seal, using appropriate seal installer and following manufacturer's instructions. ____ ____

⚠ **CAUTION:** Make sure that you drive against the outer edge of the new seal only. Driving against the inner edge can damage the seal and cause continued leakage.

---

11. Install linkage. ____ ____
12. Lower vehicle, and replace any lost fluid. ____ ____

SKILL TEST RECORD

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

EVALUATOR'S COMMENTS

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
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1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

OBJECTIVE SHEET

SERVICING TORQUE CONVERTER AND OIL PUMP

4

INTRODUCTION

The automatic transmission eliminates the clutch pedal used in manual transmissions. Instead of a solid conventional clutch, the automatic transmission uses a torque converter between the engine and the transmission. The torque converter is a fluid clutch that connects and disconnects the engine and transmission.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS

PREREADING:	Read the pages in your textbook on torque converters. Read also the pages on measuring cooler flow rate and torque converter end play in the service manual for the vehicle you will service.
WRITING:	Pretend that you must show a friend how to perform *one* of the following tasks: • Flush a torque converter. • Inspect an oil pump assembly. • Inspect a converter flex plate assembly. • Check a stator clutch. Outline the process in your notebook, noting any hazardous procedures or guidelines that you must remember to stress to your friend. Make sure that your steps are arranged in a logical sequence. Use as your example the vehicle that you will be servicing in the shop. Use the shop manual for that vehicle as your reference.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Describe the primary functions of the torque converter.
2. Label the components of a cut-away view of a lockup torque converter assembly.
3. Match torque converter components with their descriptions/ functions.
4. List advantages of the torque converter.
5. Describe conventional and lockup torque converters.
6. List the advantages of a lockup torque converter over a conventional torque converter.
7. Explain the advantages of the piston lockup-converter clutch over the centrifugal lockup-converter clutch.
8. Identify the three types of commonly used oil pumps.
9. State the functions of the transmission oil pump.
10. Label the parts of a variable-output, vane-type oil pump.
11. State indications of possible torque converter problems.
12. Measure torque converter endplay and check for interference. (Job Sheet 1)
13. Inspect oil pump assembly. (Job Sheet 2)
14. Flush torque converter. (Job Sheet 3)

INFORMATION SHEET

SERVICING TORQUE CONVERTER AND OIL PUMP

4

OBJECTIVE 1

Required Activities/
Resources in
Instructor's Guide

Describe the primary functions of the torque converter.

- Acts as a fluid coupling that smoothly transmits engine torque to the transmission gear train
- Multiplies torque from the engine to the transmission
- Provides a mechanical (or direct drive) link from the engine to the transmission with the use of a torque converter clutch (TCC)

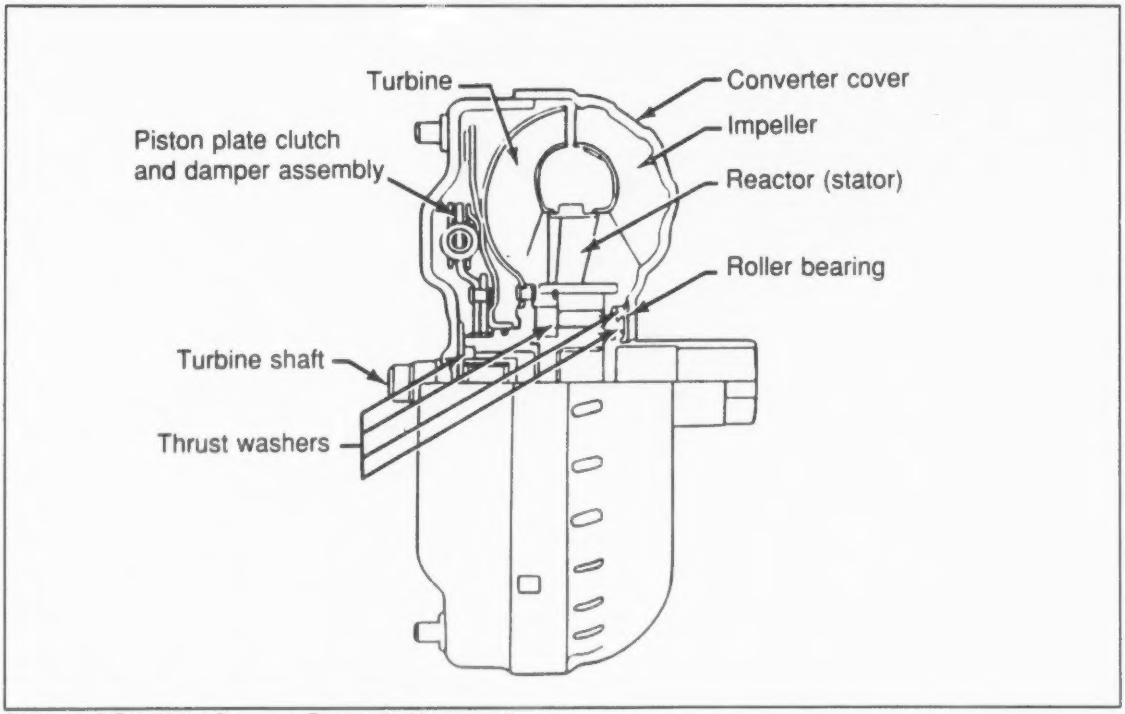
OBJECTIVE 2

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Label the components of a cut-away view of a lockup torque converter assembly.

FIGURE 1



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OBJECTIVE 3

Match torque converter components with their descriptions/ functions.

- **torque converter housing** — rigid metal component bolted to flexplate, which in turn is bolted to crankshaft; encloses and seals in the parts of the torque converter
- **flexplate** — rigid metal component that, with the torque converter, serves as a flywheel, providing the inertia to keep the crankshaft turning smoothly during periods when no power is applied; transfers crankshaft rotation to the torque converter shell
- **impeller** — driving fan that produces oil movement inside the converter when the vehicle engine is running

  ☑ **NOTE:** The impeller is sometimes called a *converter pump.*

- **turbine** — driven fan splined to the input shaft of the automatic transmission; produces rotary motion by reacting to the current of oil driven to it by the impeller

  ☑ **NOTE:** Oil is usually the only connection between the turbine and the impeller that drives it.

- **stator** — small wheel-like device between the impeller and turbine; improves oil circulation inside the torque converter, making use of all of the force produced in the moving oil
- **torque-converter clutch** — single-plate lockup clutch that locks to the input shaft; eliminates slippage
- **vane** — one of several thin, curved fins or blades in the impeller, stator, and turbine; directs fluid flow and facilitates rotation of the impeller, stator, or turbine to which it is attached

OBJECTIVE 4

Optional Activities/ Resources in Instructor's Guide

List advantages of the torque converter.

- Smooths out the transfer of engine torque to the transmission
- Acts as a hydraulic shock absorber to the driveline while loading and unloading stresses are developed during gear-ratio changes
- Acts as a cushion between the engine and transmission as a result of unfavorable driving conditions such as emergency stops

- Provides a variety of torque and speed ratios
- Dampens vibrations

OBJECTIVE 5

Optional Activities/ Resources in Instructor's Guide

Describe conventional and lockup torque converters.

- **Conventional**
    - ☐ Is considered a three-element (impeller, turbine, stator), two-stage (stall and coupling) unit
    - ☐ Was the fluid clutch used to transfer engine torque in automobiles and light trucks until the 1970s
- **Lockup**
    - ☐ Is usually considered a four-element (impeller, turbine, stator, lockup clutch), three-stage (stall, coupling, and locking) unit
    - ☐ Comes in two types: centrifugal (installed in some Ford Motor Company automatic transmissions during the 1980s) and piston (presently installed in most automatic transmissions)

OBJECTIVE 6

Optional Activities/ Resources in Instructor's Guide

List the advantages of a lockup torque converter over a conventional torque converter.

- Eliminates slippage between the impeller and turbine at the coupling stage of operation in a conventional converter
- Improves fuel economy
- Reduces torque converter operational heat

OBJECTIVE 7

Optional Activities/ Resources in Instructor's Guide

Explain the advantages of the piston lockup-converter clutch over the centrifugal lockup-converter clutch.

- The piston clutch is operated by hydraulic valve action (which is controlled by computer), whereas the centrifugal clutch is operated by turbine speed.
- Due to close computer monitoring of systems information, piston clutch engagement takes place at exactly the right time as it relates to engine operation.
- The piston clutch has fewer parts to malfunction.
- The piston clutch is less expensive.

OBJECTIVE 8

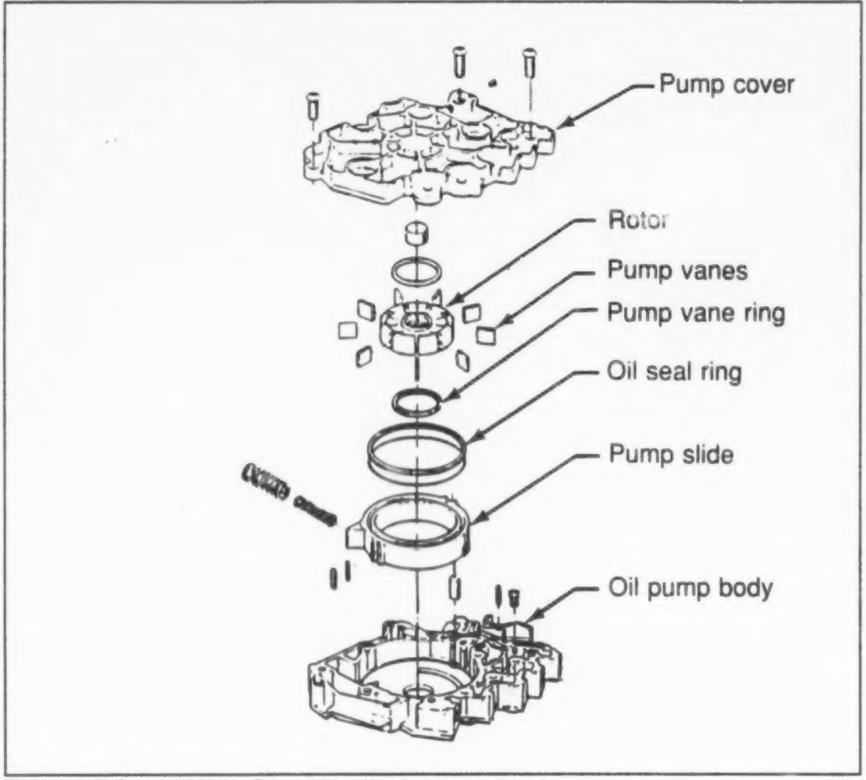
Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Identify the three types of commonly used oil pumps.

- **Variable-output, vane-type oil pump** (Figure 2)

FIGURE 2



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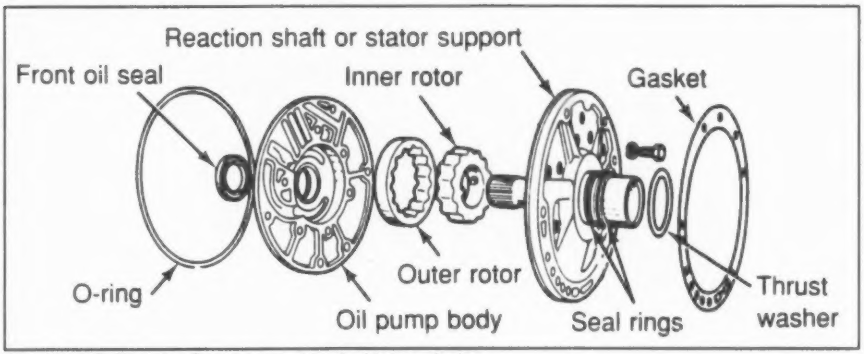
- **Rotor-type oil pump** (Figure 3)

FIGURE 3



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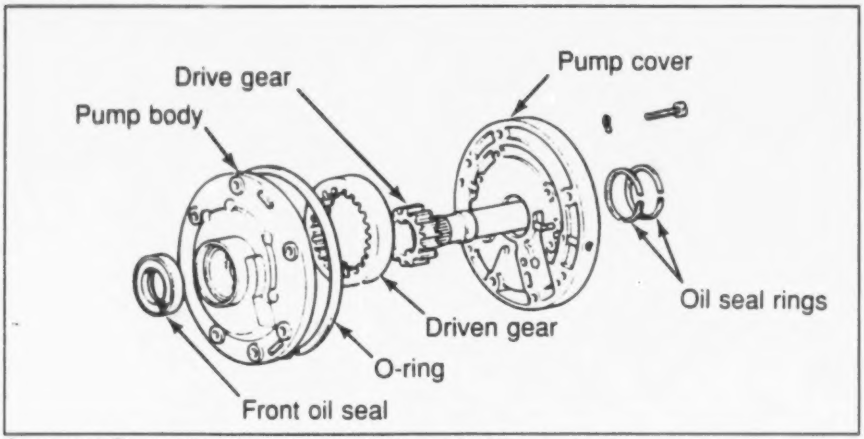
- **Gear-type oil pump** (Figure 4)

FIGURE 4



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OBJECTIVE 9

Optional Activities/ Resources in Instructor's Guide

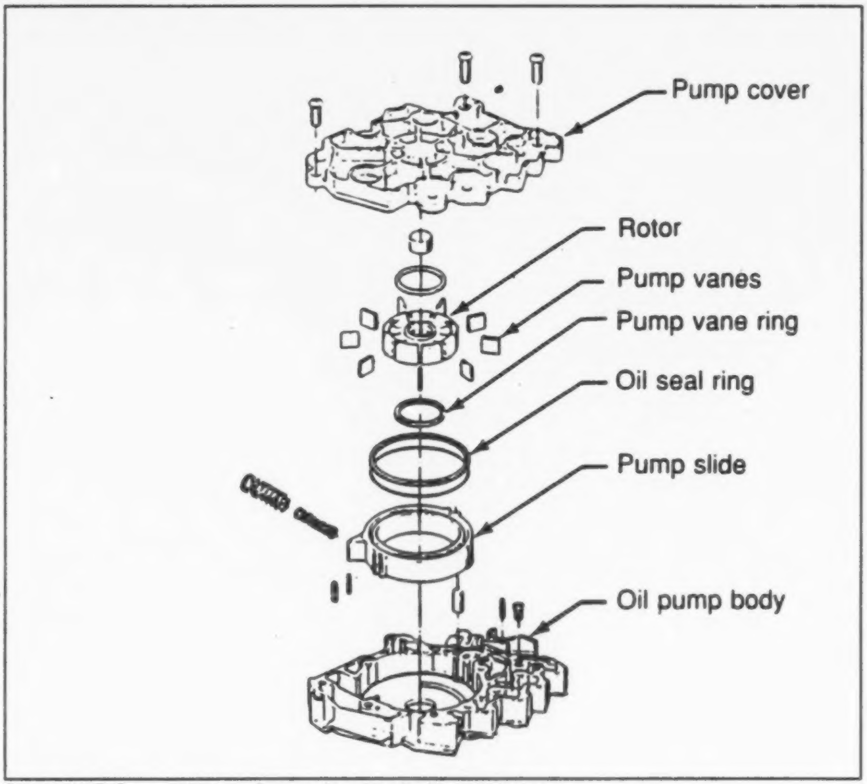
State the functions of the transmission oil pump.

- Produces pressure to operate clutches, bands, and gearsets
- Lubricates transmission's moving parts
- Keeps torque converter filled with oil for proper operation
- Circulates oil through transmission and cooling tank (radiator) to transfer heat
- Operates hydraulic valves in the transmission

OBJECTIVE 10

Label the parts of a variable-output, vane-type oil pump.

FIGURE 5



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OBJECTIVE 11

Required Activities/ Resources in Instructor's Guide

State indications of possible torque converter problems.

- Slow acceleration from a standstill
- Restricted engine rpm and vehicle speed
- Overheated transmission
- Fluid leakage

OBJECTIVES 12-14

Complete Job Sheets 1-3.

JOB SHEET 1

SERVICING TORQUE CONVERTER AND OIL PUMP

4

Name ______________________________

OBJECTIVE 12

Measure torque converter endplay and check for interference.

INTRODUCTION

After the transmission and converter have been removed from the vehicle—and if the same converter will be reinstalled in the vehicle—the technician should check the torque converter for possible defects while it is on the workbench. These checks include measuring torque converter end play and checking for interference.

EQUIPMENT AND SUPPLIES

- Vehicle
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Holding device specialty tool recommended by vehicle manufacturer
- Dial indicator
- Shop towels

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Check for stator/impeller interference. Yes No

1. Place fluid pump assembly on workbench, facing *upward*. ____ ____
2. Fit the converter over the stator support splines. ____ ____
3. Rotate the converter slightly to engage the hub with the pump drive gear in the rotor. ____ ____
4. While holding the pump to prevent it from moving, rotate the converter counterclockwise; if converter binds or makes a loud scraping noise while rotating, replace it. ____ ____

PROCEDURE

Functional Math
- Make measurements

Cognitive Activities
- Transfer knowledge/training to new situations

Check for stator/turbine interference.	Yes	No
1. Place the converter on the workbench, facing *downward.*	____	____
2. Install a pump assembly, engaging the stator support with the stator and the converter hub with the pump drive gear or rotor.	____	____
3. Insert the turbine shaft (usually the transmission input shaft in RWD vehicles).	____	____
4. Rotate turbine shaft slightly to engage its splines with turbine hub.	____	____
5. While holding the pump and converter to prevent them from moving, rotate the turbine shaft; if it does not turn freely in both directions, replace the converter.	____	____

PROCEDURE

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Measure torque converter endplay.		
1. Insert holding tool into converter hub until it bottoms.	____	____
2. Tighten tool in place to lock it into turbine spline.	____	____
3. Attach a dial indicator so that indicator button is on converter hub.	____	____
4. Zero the indicator reading.	____	____
5. Lift the holding tool upward as far as it will go.	____	____
6. Read the dial indicator; if the reading exceeds the endplay specified in the service manual, replace the converter.	____	____

☑ **NOTE:** In general, lockup converters have a maximum internal endplay of 0.050 inches or 1.27 millimeters.

PROCEDURE

Check torque converter stator clutch operation.	Yes	No
1. Inspect stator clutch splines for wear or damage.	____	____
2. Using finger, manually rotate stator; splines should *freewheel* in one direction and *lock* in the other.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
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Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
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1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

____

____

____

JOB SHEET 2

SERVICING TORQUE CONVERTER AND OIL PUMP

Name ________________________________

OBJECTIVE 13

Inspect oil pump assembly.

INTRODUCTION

A transmission may contain one of three types of oil pumps: gear, rotor, or vane. The gear-type oil pump is the most commonly used oil pump. The rotor-type pump is installed in all rear-wheel-drive Chrysler vehicles equipped with automatic transmissions. The newest oil pump is the vane-type. Its design and operation contribute to fuel economy.

The purpose of the transmission oil pump is to create fluid flow in the transmission.

EQUIPMENT AND SUPPLIES

- Vehicle
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Ratchet wrench and ratchets
- Feeler gauge
- Straight edge
- Special tool to remove pump housing bushing (see service manual)
- Appropriate seal installing tool
- RTV sealant
- Sharp knife
- Special tool to install replacement seal (see service manual)
- Appropriate lathe-cut replacement seal
- Appropriate automatic transmission fluid
- Torque wrench
- Shop towels
- Felt-tipped pen

PROCEDURE

Yes No

1. Remove the outer lathe-cut seal ring and pump seal. ____ ____

2. Disassemble pump following manufacturer's specifications. ____ ____

3. Mark the gears with a felt-tipped pen to ensure proper replacement. ____ ____

4. Wash the individual parts of the pump assembly thoroughly; dry. ____ ____

5. Spread out pump parts on workbench. ____ ____

6. Closely examine housing for cracks, nicks, burrs, or damage to sealing surfaces. ____ ____

7. Examine gears for burrs, nicks, or scratches. ____ ____

8. Examine reaction-shaft support gears for cracks and pump gear wear pattern. ____ ____

9. Use feeler gauge to measure clearance between outer pump gear and pump pocket in housing; compare findings with service manual specifications. ____ ____

10. Use feeler gauge to check clearance between *outer* pump gear teeth and the crescent; compare findings with service manual specifications. ____ ____

11. Use feeler gauge to check clearance between *inner* pump gear teeth and the crescent; compare findings with service manual specifications. ____ ____

12. Check pump-gear side clearance with a feeler gauge and straight edge; compare findings with service manual specifications. ____ ____

☑ **NOTE:** Replace the pump if it exceeds any service manual clearance specifications.

13. Remove the pump-housing bushing with the special bushing-removal tool. ____ ____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Functional Math
- Make measurements

Cognitive Activities
- Transfer knowledge/training to new situations

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
14. Install the pump seal with appropriate seal installing tool.	____	____
15. Lightly coat outside surface of seal case with RTV sealant.	____	____
16. Carefully examine seal rings on the reaction-shaft support; replace if necessary.	____	____
17. Check to ensure that seal rings rotate in their grooves.	____	____
18. Check the clearance between reaction-shaft support-ring groove and seal ring; if clearance exceeds manufacturer's specifications, replace the support shaft.	____	____
19. Place some transmission fluid in the pocket of the pump housing to provide initial lubrication and sealing.	____	____
20. Install pump gears into pump housing, observing markings to ensure that individual gears are not inverted.	____	____
21. Align and install reaction-shaft support.	____	____
22. Torque the shaft support bolts to manufacturer's specifications.	____	____
23. Lubricate and install a new lathe-cut seal in groove around pump body.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB SHEET 3

SERVICING TORQUE CONVERTER AND OIL PUMP

4

Name ____

OBJECTIVE 14 **Flush torque converter.**

INTRODUCTION

Some manufacturers recommend that you do not flush a torque converter that has a converter clutch. They believe that the cleaning solution destroys the bonding between the converter cover and the friction lining. On the other hand, some manufacturers provide flushing procedures in their shop manuals for clutch-type torque converters. If you have any doubts, replace the torque converter rather than flush it.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Torque converter flushing machine and instruction booklet
- Approved transmission fluid
- Closed-end pop rivet to plug drilled drain hole
- Cooler fitting plug
- Dummy input and stator shafts
- Shop towels
- Waste container for cleaning solution and old transmission fluid
- Cleaning solution recommended by flushing machine manufacturer or vehicle service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Inspect torque converter. Yes No

1. Inspect the torque converter for the following defects: ___ ___
    - Metal contamination
    - Water contamination
    - Damaged hub or pilot
    - Damaged body
    - Leaking welds
    - Excessive endplay
    - Defective starter clutch
2. Replace (rather than flush) the torque converter if *any* listed defects are found. ___ ___

PROCEDURE

Functional Math
- Make measurements

Cognitive Activities
- Transfer knowledge/training to new situations

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Machine-flush a torque converter.

1. Read flushing-machine instruction booklet. ___ ___
2. Bolt converter to flushing-machine mounting plate per instruction booklet. ___ ___
3. Connect the proper hoses per instruction booklet. ___ ___
4. Apply air from the machine in short blasts, allowing the converter to fill between blasts. ___ ___

    ☑ **NOTE:** Some flushing machines automatically apply air in short blasts.

5. Continue procedure until solution runs clear from converter. ___ ___
6. Shut off solution flow, following directions in flushing-machine instruction booklet. ___ ___
7. Pump recommended amount of appropriate transmission fluid into the converter. ___ ___
8. Apply air from the machine in short blasts until all fluid has been forced from converter. ___ ___

	Yes	No
9. Disconnect flushing lines from converter.	____	____
10. Disconnect converter from mounting plate.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

____

____

____

OBJECTIVE SHEET

SERVICING GEAR TRAIN/GEARSETS

5

INTRODUCTION

In a manual transmission, a clutch is used to disengage power before gears can be shifted properly. An automatic transmission is shifted without disconnecting engine power from the transmission. A special gear system is used that does not require manual shifting to change gears. To do this, automatic transmissions use a planetary gearset. A gearset is simply a series of gears.

The main mechanical parts of an automatic transmission are gears, shafts, and clutches. In a rear-wheel drive vehicle, the gear ratios of the transmission and rear axle are used to control engine rpm and to provide the necessary torque. The transmission acts as a torque and speed changer. Any time a smaller gear, called a pinion, drives a larger gear, gear reduction and torque multiplication occur.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension

- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language

- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition

- Use complete sentences

FOCUS ASSIGNMENTS	
PREREADING:	Read the material in your textbook about gear trains and gearsets. Study the drawings of the different planetary gear positions.
WRITING:	Write a paragraph in which you describe the functions and basic operation of a simple planetary gearset.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Match types of gears and gearsets with their characteristics.
2. Label the parts of a simple planetary gearset.
3. Explain planetary gearset power flow.
4. Label the parts of a typical planetary gear train assembly.
5. State the purposes of holes in shafts.
6. State reasons for replacing oil delivery seal rings.
7. State reasons for replacing bushings.
8. Label the parts of a parking pawl assembly.
9. Disassemble, inspect and reassemble planetary gear assemblies. (Job Sheet 1)
10. Inspect transmission housing. (Job Sheet 2)
11. Remove and inspect shafts. (Job Sheet 3)
12. Remove and replace oil delivery seal rings. (Job Sheet 4)
13. Remove, inspect, and replace bushings. (Job Sheet 5)
14. Inspect parking pawl assembly. (Job Sheet 6)
15. Remove and replace speedometer drive gear, driven gear, and retainers. (Job Sheet 7)

INFORMATION SHEET

SERVICING GEAR TRAIN/GEARSETS

5

OBJECTIVE 1

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Match types of gears and gearsets with their characteristics.

☞ Your instructor will display each of the types of gears and gearsets described.

- **idler gear** — a third gear meshed between two (usually larger) gears, the only function of which is to make the input and output direction the same
- **spur gear** — gear with teeth parallel to gear axis
- **helical gear** — gear with teeth at an angle to gear axis
- **pinion gear** — any gear considerably smaller than the one with which it meshes
- **rack and pinion gearset** — a flat box gear and a pinion gear; changes rotary motion to linear travel perpendicular to the axis of rotation
- **bevel gearsets** — connect two shafts rotating at an angle to each other
- **ring gear** — gear that resembles a ring rather than a disc; sometimes called an annulus gear
- **worm and worm gear** — coiled or cylindrically shaped gear, whose diameter is usually only slightly larger than its shaft, and a circular helical or spur gear; used to drive elements whose axes are at right angles

  EXAMPLE: Driving the speedometer off the transmission output shaft
- **planetary gearset** — group of gears that orbit, or circle, a central gear; they are held in place by the planet carrier and ring gear

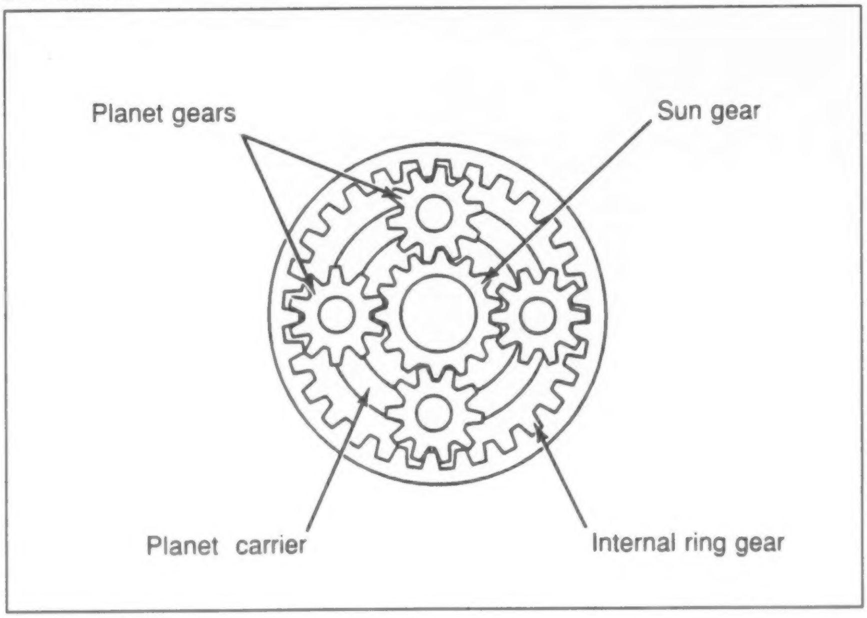
OBJECTIVE 2

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Label the parts of a simple planetary gearset.

FIGURE 1



OBJECTIVE 3

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Explain planetary gearset power flow.

WORDS YOU SHOULD KNOW	
constant-mesh gearset	gearset in which the teeth of each gear are meshed at all times with the teeth of another gear
compound planetaries	two or three planetary gearsets linked together in the automatic transmission; each gearset is controlled by a common or separate sun gear ☑ **NOTE:** A three-speed automatic transmission has two planetary gearsets. A four-speed overdrive automatic transmission has two or more planetary gearsets.
driving member	member of planetary gearset driven by the power source; provides output power to the transmission
driven member	output member of planetary gearset driven by the driving member; transmits torque to driveline

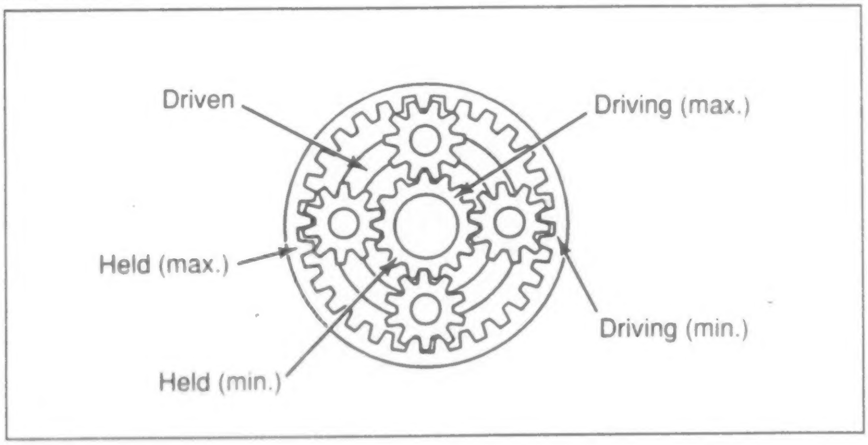
WORDS YOU SHOULD KNOW

planetary gearset	group of planet gears that orbit, or circle, a sun gear; they are held in place by a planet carrier and ring gear
Ravigneaux planetary gearset	compound planetary gearset with two sun gears (small primary and larger secondary), three long and three short planet gears, a planet carrier, and a ring gear
reaction member	member of planetary gearset that is held and prevented from moving
reduction	the difference between a given input speed (rpm) that results in a lower output speed (rpm); multiplied torque causes the output speed to decrease
Simpson gear train	two simple planetary gearsets mounted on a common sun gear

- Forward reduction (Figure 2)

	Max. reduction	Min. reduction
☐ **Driving (input)**:	sun gear	ring gear
☐ **Driven (output)**:	planet carrier	planet carrier
☐ **Held:**	ring gear	sun gear

FIGURE 2

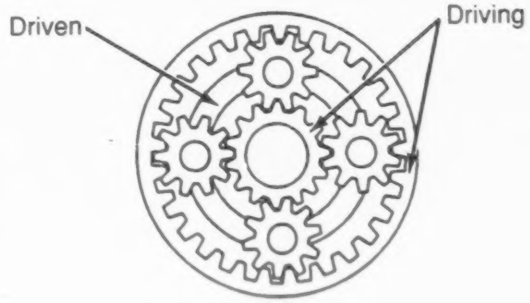


- Direct drive (Figure 3)
  - ☐ **Driving (input)**: sun gear and ring gear (locked together)

☐ **Driven (output)**: planet carrier

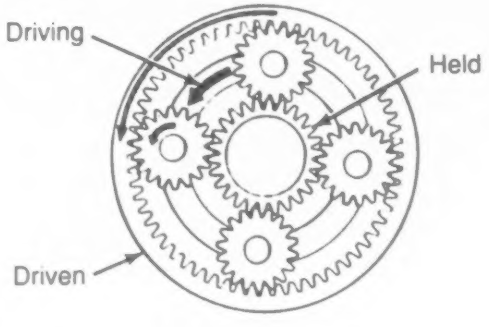
☑ **NOTE:** In direct drive, any two members of the planetary gearset rotate in the same direction at the same speed, forcing the third member to also rotate at the same speed. The planet gears do not rotate but act as wedges to drive the entire gearset as one complete rotating part.

FIGURE 3



- Overdrive (Figure 4)
    - ☐ **Driving (input)**: planet carrier
    - ☐ **Driven (output)**: ring gear
    - ☐ **Held**: sun gear

FIGURE 4



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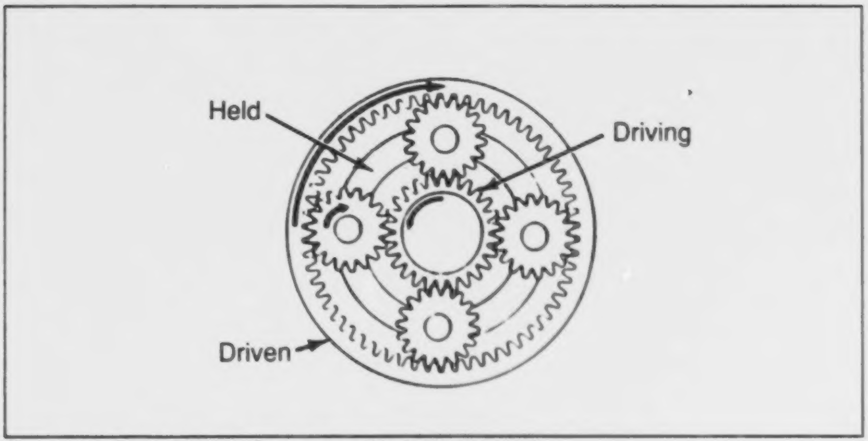
- Reverse (Figure 5)
  - ☐ **Driving (input)**: sun gear
  - ☐ **Driven (output)**: ring gear
  - ☐ **Held:** planet carrier

FIGURE 5



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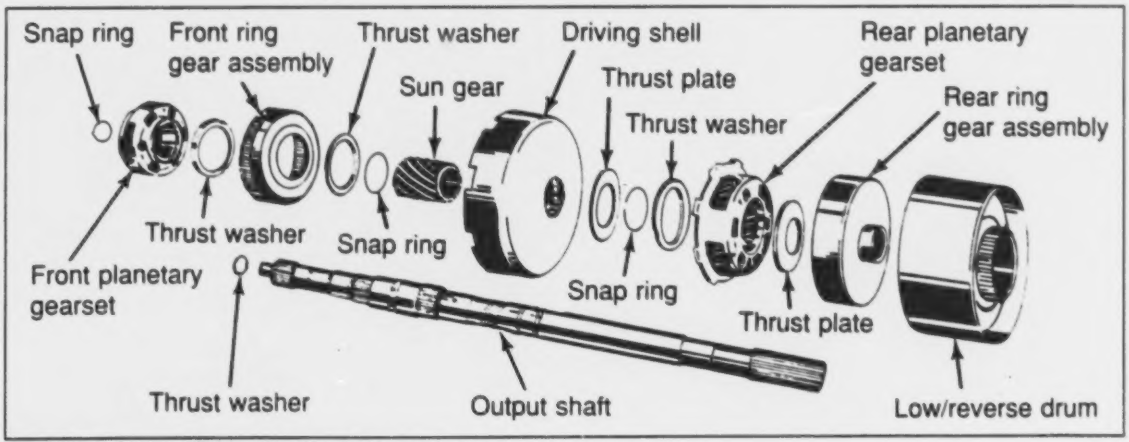
OBJECTIVE 4

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Label the parts of a typical planetary gear train assembly.

FIGURE 6



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OBJECTIVE 5

Optional Activities/
Resources in
Instructor's Guide

State the purposes of holes in shafts.

- To provide oil to the various clutch packs and planets
- To provide oil to the various gearsets
- To provide oil to the various bushings

OBJECTIVE 6

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

State reasons for replacing oil delivery seal rings.

WORDS YOU SHOULD KNOW	
butt joint	type of seal joint end used when small leakage past the joint is not important or when a nonpositive seal is desired
dynamic seal	seal between two rotating or reciprocating (moving) parts
hook joint	type of seal joint end used where control of fluid leakage is required and where compression is initially needed to fit the ring to its bore
nonpositive seal	seal that allows some minor leakage for lubrication
positive seal	seal that completely prevents leakage
static seal	seal between two parts that do not move in relation to one another

☑ **NOTE:** For the most part, "service" of transmission seal rings means replacing them.

- Unwanted internal or external leakage
- Cracks
- Deterioration or other damage

OBJECTIVE 7

Optional Activities/
Resources in
Instructor's Guide

State reasons for replacing bushings.

- Wear
- Scoring
- Damaged shaft
- Lack of lubrication

OBJECTIVE 8

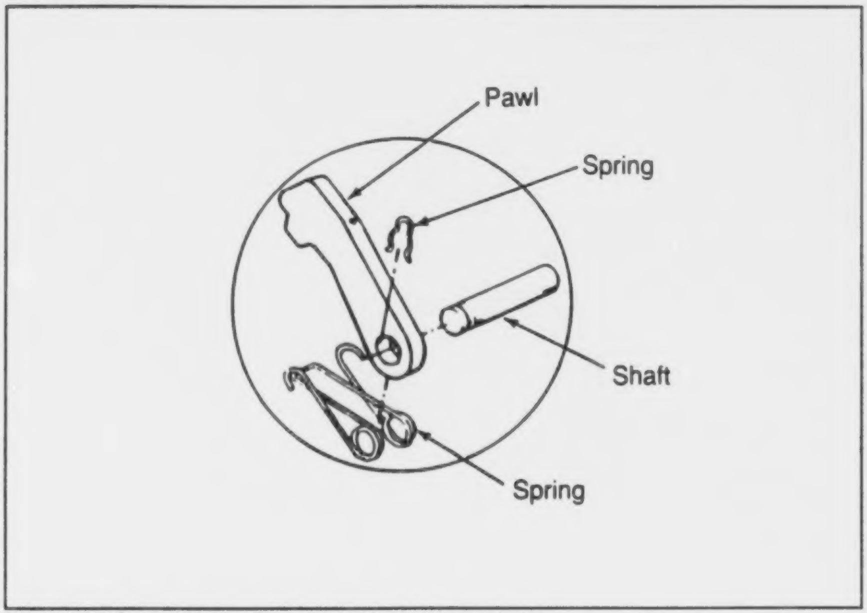
Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Label the parts of a parking pawl assembly.

WORDS YOU SHOULD KNOW	
actuate	to put into mechanical action or motion
pawl	a pivoted projecting part that engages with gear teeth or with the notches in a gate
pivot	pin or shaft about which a part moves; to move or turn as though on a pivot

FIGURE 7



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OBJECTIVES 9-15

Complete Job Sheets 1-7.

JOB SHEET 1

SERVICING GEAR TRAIN/GEARSETS

Name ____________________

OBJECTIVE 9

Disassemble, inspect, and reassemble planetary gear assemblies.

INTRODUCTION

A critical part of overhaul is knowing how to identify worn and damaged parts. It is important to inspect and clean all planetary gear assemblies. Always check planetary gear assemblies for the following defects:

- Roughness or binding in outer or inner races of pinion gears, bearings, and thrust washers
- Thrust washers showing signs of abnormal wear, broken mounting tabs, or worn oil grooves
- Damaged or badly worn gear teeth and splines
- Loose or broken pinions, pinion shafts, and lockpins
- Blue pinion gear shafts in planet carrier (indicate overheating from poor lubrication)
- Worn or scored sun gear bushings
- Distorted snap rings
- Cracked or broken carriers

EQUIPMENT AND SUPPLIES

- Benched transmission or transaxle
- Eye protection
- Basic hand tool set
- Appropriate automatic transmission overhaul kit
- Recommended lubricant
- Mineral spirits
- Carburetor cleaner or appropriate cleaning solution
- Feeler gauge
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Yes No

1. Before disassembling the planetary gear train, check end play to determine the condition of the thrust washers.

    - Stand entire gear train assembly on a block of wood with only the end of the output shaft touching the wood. ____ ____

    - Measure end play by inserting the feeler gauge between the shoulder on the output shaft and the hub of the rear ring gear. ____ ____

    - Compare end play measurements to manufacturer's specifications. ____ ____

2. Remove the snap ring and thrust washer from the front planetary ring gear. ____ ____

⚠ **NOTICE:** Keep all thrust washers and gear train parts in proper order.

---

3. Inspect thrust washer for wear or damage: abnormal wear patterns such as brass worn through metal backing, worn down oil grooves, broken mounting tabs. ____ ____

4. If gear train end play is out of specification, follow manufacturer's recommendation for repair or replacement. ____ ____

5. Inspect the front ring gear outer splines for burrs and distortion. ____ ____

    ☑ **NOTE:** The forward clutch friction discs must slide on these splines during engagement and disengagement.

6. Inspect the gear teeth around the inside of the front planetary ring gear for wear or damage. ____ ____

7. Remove the front planetary carrier from the internal part of the ring gear and examine the thrust washer for broken mounting tabs and abnormal wear patterns as in Step 3. ____ ____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Functional Math
- Make measurements

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

8. Examine the front planetary gears for end play.
   - Place a feeler gauge between the planetary carrier and the planetary pinion gear. ____ ____
   - Compare the end play with the clearance specifications in the service manual. ____ ____

9. If necessary, return end play to manufacturer's specifications by inserting shims according to service manual instructions. ____ ____

   ☑ **NOTE:** The planetary carrier shims used to reduce planetary pinion end play are available only for vehicles with planetary pinion thrust washer wear problems.

10. Check to see that the planetary pinion gear shafts are securely locked in the planetary carrier, and that all pinion gears are secure on the shaft. ____ ____

11. Replace entire assembly if any pinion gears are loose. ____ ____

12. Inspect the planetary carrier spline to the output shaft spline for stripping. ____ ____

    ☑ **NOTE:** If these splines are stripped, all forward gear ranges will be affected.

13. Inspect all bushing surfaces on output shaft for nicks, scoring, or other damage; remove slight nicks or burrs with a fine stone. ____ ____

14. Inspect the fit of the sun gear and sun gear shell. ____ ____

15. Check the fit of the sun gear bushings on the output shaft. Replace the bushings if they are loose. ____ ____

16. Inspect all gear teeth for wear or damage. ____ ____

Yes No

17. Inspect the rear planetary carrier and planetary gearset following the procedures outlined above for the front planetary carrier and pinion gears. ____ ____

18. After inspection, clean all gear train parts in mineral spirits and air dry. ____ ____

☑ **NOTE:** Soak parts with varnish deposits in appropriate cleaning solution..

19. Blow out oil passages in output shaft. ____ ____

⚠ **NOTICE:** Do not allow the compressed air to spin the gears in the gearset as this may damage the bearings.

---

20. Reassemble the planetary drive train, and install thrust washers and snap rings; use petroleum jelly to hold thrust washers in place during reassembly. ____ ____

21. After reassembly, make a final check of gear train end play. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB SHEET 2

SERVICING GEAR TRAIN/GEARSETS

5

Name ____

OBJECTIVE 10

Inspect transmission housing.

INTRODUCTION

After the case is cleaned, the specialist should make a careful inspection of the transmission housing and all threaded holes. It is very time consuming to have to repair a stripped or damaged hole after all the parts have been reinstalled. Two especially critical areas that need checking are the valve body and front pump attaching bolt holes.

EQUIPMENT AND SUPPLIES

- Benched transmission or transaxle
- Eye protection
- Basic hand tool set
- Appropriate automatic transmission overhaul kit
- Special tap for rethreading damaged holes
- Thread inserts
- Seal installers and replacers specific to make and model being serviced
- Clean heavy grease
- Mineral spirits
- Carburetor cleaner
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions

Inspect transmission case. Yes No

1. Inspect case for porosity or other visible damage. ____ ____

2. Inspect all threaded holes for damaged or stripped threads, paying particularly careful attention to the pump threads. ____ ____

- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
3. Repair any stripped threads.		
• Select correct drill size to enlarge hole, using chart furnished by insert manufacturer.	____	____
• Carefully drill hole, removing all existing threads.	____	____
• Coat end of special tap with heavy grease to hold shavings.	____	____
• Tap the hole to accept the insert.	____	____
• Thread insert on installing tool.	____	____
• Thread insert into tapped hole, making sure that the top of the insert is below the surface of the case.	____	____
• Remove installing tool.	____	____
• Break off the tab at the bottom of the insert with a screwdriver or other suitable tool.	____	____
• Carefully remove the broken tab.	____	____
• Reclean case with dry air.	____	____
4. Inspect all sleeves and bores for scratches or wear.	____	____
5. Inspect input and output shaft support for grooves or damage; replace case if damaged.	____	____
6. Inspect cooler inlet and outlet fittings for damage.	____	____

☑ **NOTE:** If fittings are the plastic quick-disconnect type, check for cracks or breakage.

7. After case is cleaned, install new manual lever shaft seal.	____	____

PROCEDURE

Inspect extension housing (RWD). Yes No

1. Remove rear seal. ____ ____

2. Remove bushing from extension housing, taking care not to damage housing where bushing rides. ____ ____

☞ **NOTE:** If special tool is not available, the bushing can be threaded and removed with a slide hammer, carefully cut from the housing with a bushing-cutter, or collapsed with a chisel and hammer and removed.

3. Clean housing with mineral spirits or carburetor cleaner, and air dry. ____ ____

4. Inspect housing for porosity or any other visible damage. ____ ____

5. Install new extension housing bushing (Job Sheet 5), following service manual instructions. ____ ____

6. Install new rear seal (Unit 3, Job Sheet 3) taking care not to distort seal during installation. ____ ____

7. Inspect output shaft bearing for wear or damage. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

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EVALUATOR'S COMMENTS

____

____

____

JOB SHEET 3

SERVICING GEAR TRAIN/GEARSETS

Name ______________________________

OBJECTIVE 11

Remove and inspect shafts.

INTRODUCTION

Shafts serve not only to transmit torque and provide an axis for rotating parts, but also the holes in hollow shafts provide oil to the various clutch packs. The holes should be inspected for clogging, and should be blown clean with shop air if necessary. There are a number of shafts in a transmission: direct drive shaft, turbine shaft, output shaft, manual shaft, oil pump shaft, and idler gear shaft, to name the most obvious.

Guidelines

- Take care not to damage the case housing when removing shafts.
- Remove shafts in the correct order and use the proper tools and techniques.
- Inspect shafts for scoring, stripping, straightness, and abnormal wear.
- Clean shafts with mineral oil or appropriate cleaning solution, and allow to air dry.
- Clean shaft oil passages by blowing out with compressed air.
- Inspect all journals for scoring, scratches, undercuts, and diameter.

EQUIPMENT AND SUPPLIES

- Benched planetary gear train
- Eye protection
- Basic hand tool set
- Appropriate automatic transmission overhaul kit
- Mineral oil
- Carburetor cleaner or appropriate cleaning solution
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	___	___
2. Located and inspected shafts for scoring and other damage.	___	___
3. Removed parts in proper sequence, using appropriate tools.	___	___
4. Installed output shaft support if needed.	___	___
5. Took care not to damage case housing.	___	___
6. Cleaned shafts with mineral oil or appropriate cleaning solution and air dried.	___	___
7. Cleaned shaft oil passages by blowing out with compressed air.	___	___
8. Followed all safety procedures.	___	___

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB SHEET 4

SERVICING GEAR TRAIN/GEARSETS

5

Name ______________________________

OBJECTIVE 12 **Remove and replace oil delivery seal rings.**

INTRODUCTION

Seal rings may be made of metal, Teflon®, or rubber. Metal and Teflon® seal rings serve to retain fluid pressure and to act as a dam, directing fluid pressure from a stationary to a moving part. Metal seal rings allow minimal leakage; properly installed Teflon® seal rings do not leak.

The main purpose of rubber seal rings is to retain fluid pressure in a particular area. Rubber seal rings are made of a synthetic rubber suitable for the majority of vehicle sealing applications. Rubber seal rings are inexpensive and resist oil and abrasion damage; however, they have a tendency to harden and become inflexible with high transmission temperatures. Hardened rubber seal rings cannot seal properly, and thus allow pressurized fluid to leak.

The selection and replacement of metal or rubber seal rings is critical when overhauling an automatic transmission. Automatic transmission overhaul kits contain many different sizes of seal rings for different models of the same automatic transmission. Because size variations in cross section and total diameter are sometimes very slight and easy to overlook, selection of the correct ring for the location can be difficult. For this reason, precise comparison of the new with the old seal ring is essential.

Guidelines

- Always carefully check new seal ring against removed seal ring to ensure that it is the same size—both in cross section and total diameter—and type.
- Before installing, check each seal ring for fit. (See Unit 3, Objective 6.) Check each seal ring, one at a time, on pistons that contain multiple seal rings.
- Allow a slight gap (see manufacturer's specifications) between the ends of metal sealing rings to allow for expansion of the ring.

495

- When installing a lipped seal ring, take care not to catch the seal lip on the edge of the bore. This can cut the seal lip and cause a fluid leak. To ease the installation of lipped seal rings, use a wax lubricant, the proper installing tool, a seal guide, and precompress the seal lip.

- Always install lipped seal rings with the lips facing the direction recommended in the service manual.

- Take care when installing the next unit on top of a scarf-cut Teflon® sealing ring. The ends tend to stick out and they can get caught and cut during installation.

- Always lap the ends of scarf-cut Teflon® seal rings on the correct sides.

- Use the special removal and installation tools recommended in the service manual.

EQUIPMENT AND SUPPLIES

- Benched transmission or transaxle
- Eye protection
- Basic hand tool set
- Appropriate automatic transmission overhaul kit
- Recommended lubricant
- Solvent
- Feeler gauge
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	___	___
2. Located and properly removed seal rings.	___	___
3. Carefully compared replacement seal ring with old seal ring for proper size—both in cross section and total diameter—and type.	___	___
4. Checked each seal ring for fit before installing.	___	___

	Yes	No
5. Used the special removal and installation tools recommended in the service manual.	___	___
6. Followed all safety procedures.	___	___

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

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____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

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2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB
SHEET 5

SERVICING GEAR TRAIN/GEARSETS

5

Name ______________________________

OBJECTIVE 12 **Remove, inspect, and replace bushings.**

INTRODUCTION

Bushings are plain metal bearings used to align, support, and protect rotating shafts and to seal fluids. When supporting a shaft, the bushing also protects it because the bushing wears rather than the more expensive part or assembly.

Bushings are located in several places in the transmission case, including the governor, extension housing, and rear of the case. Several parts also have bushings, including the input ring gear, reaction carrier, pump body, pump cover, front and rear stator support to turbine shaft, direct clutch, and sun gear.

To avoid damage to the parts, specialized tools are required for bushing removal and replacement. If the new bushings are not installed properly, they will be too tight and may overheat and burn up in service. Bushing replacement is part of normal overhaul.

Guidelines

- Judge bushing condition by appearance and feel. Replace if you find any galling, scoring, flaking, excess wear, or observe rough operation.
- Most manufacturers do not publish clearance or size specifications for bushings. If you want to measure bushing clearance to gain experience, use the rule of thumb that anything over 0.006 inch is excessive.
- Several methods can be used to remove a bushing, depending on the shape of the bore and the size of the bushing. Use service manual recommended methods and tools.
- If a bushing cutter or sharp chisel is recommended for removing bushings from stepped bores, locate the seam in the bushing and work next to it, folding the bushing inward to collapse it for removal.

- Remove very small bushings by cutting threads in them and threading the slide hammer into the bushing.

  ☑ **NOTE:** A slide hammer is often used with the special removal tools. It either threads into the bushing or enters it and expands to provide a secure hold.

- To prevent damaging the bushing or its bore, always use a bushing installer to push the new bushing into its bore.

- When installing a bushing, be sure to press or drive it into its bore to the correct depth.

  ☑ **NOTE:** Some bushing installers (drivers) have steps that bottom out and stop at the correct depth.

EQUIPMENT AND SUPPLIES

- Benched transmission or transaxle
- Eye protection
- Basic hand tool set
- Appropriate automatic transmission overhaul kit
- Recommended lubricant
- Solvent
- Feeler gauge
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	____	____
2. Inspected all bushing surfaces for nicks, scoring, or other damage; removed slight nicks or burrs with a fine stone.	____	____
3. Inspected shafts for scoring and other damage.	____	____
4. Replaced any loose or damaged bushings.	____	____

	Yes	No
5. Used appropriate removal and replacement tools.	____	____
6. Followed all safety procedures.	____	____

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

SKILL TEST RECORD

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1

Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

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EVALUATOR'S COMMENTS

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JOB SHEET 6

SERVICING GEAR TRAIN/GEARSETS

5

Name ______________________________

OBJECTIVE 14 **Inspect parking pawl assembly.**

INTRODUCTION

Every automatic transmission and transaxle include a *park* range that prevents the transmission output shaft from turning. The park gear is often built onto one of the members of the planetary gearset, attached to the governor support, or a separate park gear and parking pawl. The parking pawl is mounted on a pivot pin that is mounted in the case.

In all gear positions except PARK, the parking pawl is held away from the park gear teeth by a spring. When the gear selector is moved to PARK, a circular cam on the end of the park-actuating rod pushes the pawl into mesh with the gear teeth, holding the gear and output shaft stationary.

The actuating cam is spring loaded so that if the gear teeth are in the wrong position, the gear selector lever can still be shifted into PARK, and if the output shaft rotates, the spring moves the cam, which in turn moves the pawl into complete engagement.

Guidelines

- Inspect all components (gear teeth, spring, pawl) for wear or damage.
- Inspect manual shaft (if applicable) for freedom of movement and other damage.
- Check shaft hole in pawl for wear and concentricity (roundness).

EQUIPMENT AND SUPPLIES

- Benched transmission or transaxle
- Eye protection
- Basic hand tool set
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedures in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	——	——
2. Inspected gear teeth, spring, and pawl for wear or damage.	——	——
3. Inspected manual shaft (if applicable) for freedom of movement and other damage.	——	——
4. Checked shaft hole in pawl for wear and concentricity (roundness).	——	——
5. Replaced any damaged parts.	——	——
6. Followed all safety procedures.	——	——

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

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Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

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EVALUATOR'S COMMENTS

____

____

____

JOB SHEET 7

SERVICING GEAR TRAIN/GEARSETS

5

Name ____

OBJECTIVE 15

Remove and replace speedometer driven gear and retainers.

INTRODUCTION

The speedometer driven gear is a small plastic or metal gear that sits on the output shaft of the transmission. It drives another small plastic gear which is usually mounted in a hole in the side of the transmission. Some new speedometers are electronically computerized and have a magnetic sensor ring on the shaft and a pickup assembly mounted in the transmission tailhousing.

EQUIPMENT AND SUPPLIES

- Benched transmission or transaxle
- Eye protection
- Basic hand tool set
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

	Yes	No
1. Remove snap ring or bolt and lockplate holding speedometer driven gear housing in the transmission.	____	____
2. Remove speedometer gear housing from its hole in side of transmission.	____	____
3. Remove gear from its housing and inspect.		
• Gear teeth for wear and damage.	____	____
• Number of teeth on the gear.	____	____
4. Replace old gear with one of same size and having exact number of teeth as original.	____	____
5. Reinstall speedometer housing in transmission, properly indexing the housing if appropriate.	____	____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
6. Secure speedometer gear housing with snap ring or bolt and lockplate.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

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Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

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1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

OBJECTIVE SHEET

SERVICING FRICTION UNITS AND COOLER

6

INTRODUCTION

Automatic transmission clutches and bands are friction devices that drive or lock planetary gearset members. They are used to cause the gearsets to transfer power.

Clutch assemblies usually consist of a drum, hub, apply piston, spring(s), driving discs, driven discs, pressure plate, and snap rings. During clutch operation, oil pressure is routed into the clutch drum. Oil pressure acts on the piston, forcing it into the clutch discs. Friction locks the driving and driven discs together to transfer power through the clutch assembly.

Automatic transmission bands are also friction devices for holding members in planetary gearsets. Two or three bands are commonly used in modern transmissions. Servos are apply pistons that apply the bands. When oil pressure enters a servo pressure chamber, the servo piston slides up in the cylinder. The actuating rod then pushes on the band to squeeze it inward on the drum.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

FOCUS ASSIGNMENTS	
PREREADING:	Read the pages in your textbook on automatic transmission friction units. Read also the pages on automatic transmission clutch assembly, sprag and roller clutches, and bands and drums in the service manual for the vehicle you will service.
WRITING:	Pretend that you must explain to a friend how a multiple-disc clutch assembly or sprag or roller clutches work. In a paragraph or two, outline your explanation in your notebook. Make your explanation as clear and simple as possible.

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Label the parts of a multiple-disc clutch assembly.
2. State the functions of clutch assembly components.
3. Describe types of piston return spring arrangements.
4. Explain clutch operation.
5. Explain the importance of clutch pack clearances.
6. Label the parts of a sprag clutch.
7. Label the parts of a roller clutch.
8. Explain how sprag and roller clutches work.
9. Label the parts of a typical band/servo assembly.
10. State the functions of band and servo components.
11. State the functions of internal and external coolers.
12. Distinguish between descriptions of internal and external coolers.
13. Disassemble, inspect, replace, and reassemble a multiple-disc clutch assembly. (Job Sheet 1)
14. Measure and adjust clutch pack clearance. (Job Sheet 2)
15. Air test clutch pack and internal servo assemblies. (Job Sheet 3)

16. Inspect and replace sprag and roller clutches. (Job Sheet 4)

17. Inspect and adjust bands and replace or refinish drums. (Job Sheet 5)

18. Leak test and service cooler and lines. (Job Sheet 6)

19. Measure cooler flow rate. (Job Sheet 7)

20. Reassemble transmission. (Job Sheet 8)

21. Reinstall and adjust transmission. (Job Sheet 9)

INFORMATION SHEET

SERVICING FRICTION UNITS AND COOLER

6

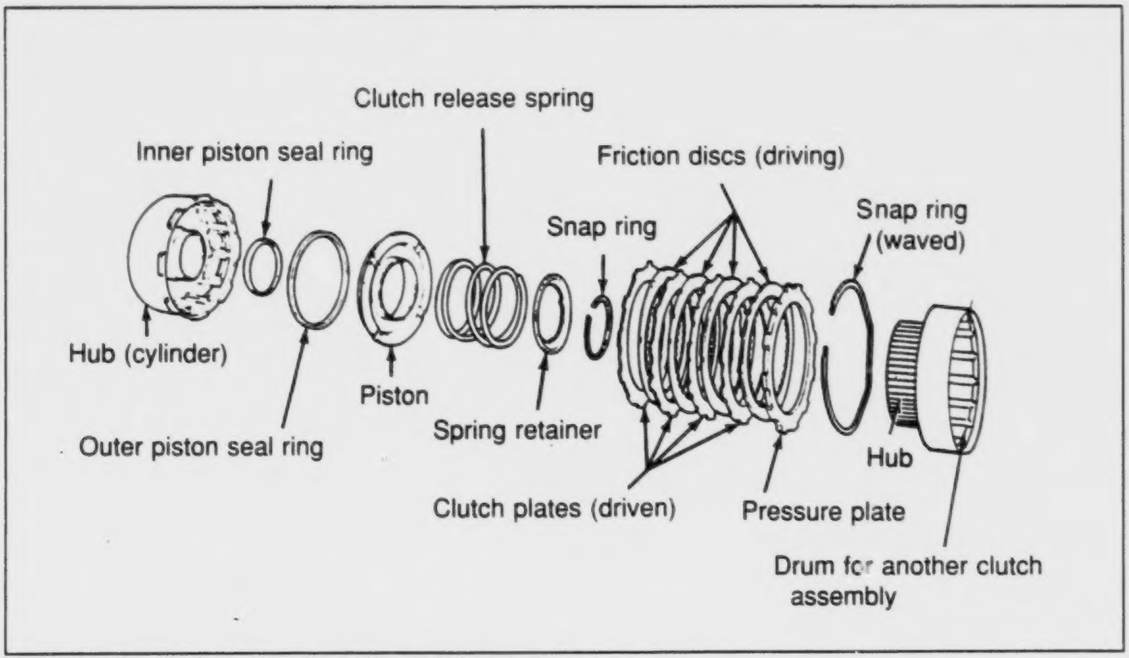
OBJECTIVE 1

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Label the parts of a multiple-disc clutch assembly.

FIGURE 1



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OBJECTIVE 2

Required Activities/ Resources in Instructor's Guide

State the functions of clutch assembly components.

- **clutch drum (clutch cylinder)** — enclosing components of clutch assembly
- **clutch hub** — engaging driving disc teeth

- **friction discs** — meshing with splines on clutch assembly hub and driving clutch plates to transmit engine torque

  ☑ **NOTE:** Clutch discs and plates transmit engine torque when squeezed between the pressure plate and piston.

- **clutch plates** — turning (being driven) to transmit engine torque when clutch is activated

- **clutch apply piston** — forcing clutch plates against the pressure plate so that discs, plates, input shaft, and clutch drum rotate as a unit

- **pressure plate** — thick steel plate held into clutch drum by snap ring; provides opposing reaction to movement of piston, thereby compressing driven friction plates between driving steel units

- **clutch spring** — overcoming reduced fluid pressure in the clutch drum and returning piston to released position after clutch disengagement

- **piston seal ring** — retaining fluid pressures used to stroke the clutch apply piston

- **snap ring** — holding pressure plate in clutch drum

OBJECTIVE 3

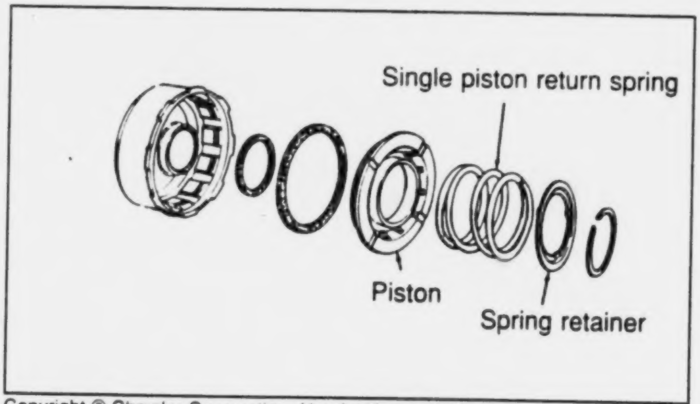
Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Describe types of piston return spring arrangements.

- **single coil spring** — one large, coiled spring (Figure 2)

FIGURE 2



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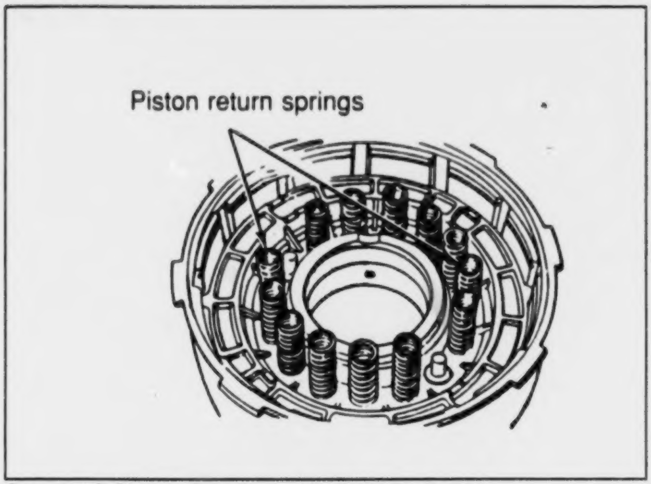
- **multiple coil springs** — several coil springs that operate the same as a single coil spring (Figure 3)

FIGURE 3



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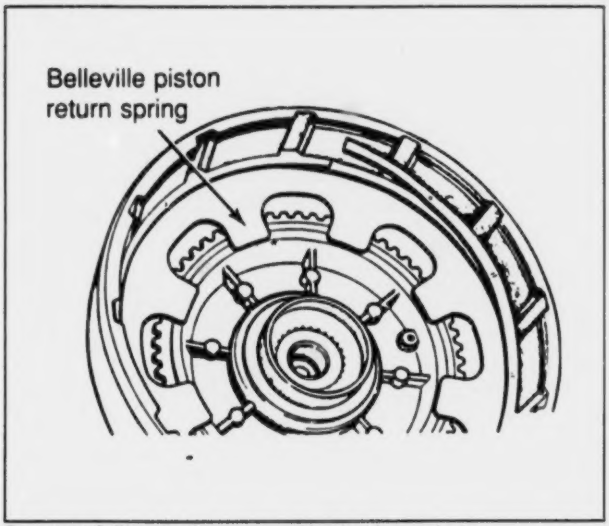
- **diaphragm spring (Belleville spring)** — spring with several levers projecting from center to outside; levers multiply piston engagement force on clutch pack to reduce chance of clutch slippage; *found mostly in rear clutches* (Figure 4)

FIGURE 4



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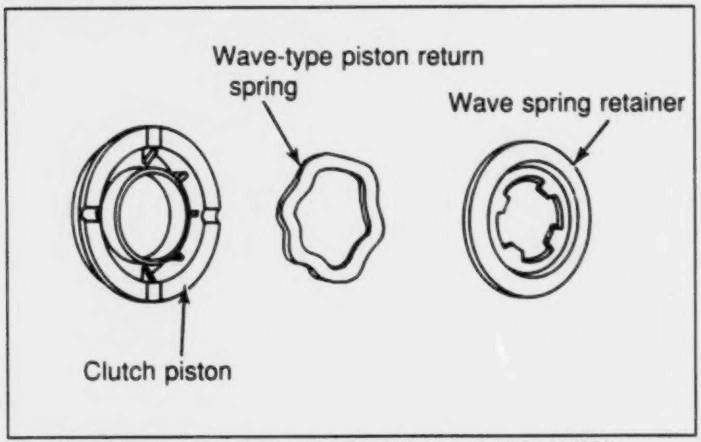
- **wave-washer spring** — newest and smallest of piston return springs, the wave washer simply flattens and stores tension when the clutch engages and releases this tension to move the clutch piston to the disengaged position when the clutch disengages (Figure 5)

FIGURE 5



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OBJECTIVE 4

Required Activities/ Resources in Instructor's Guide

Explain clutch operation.

- Disengaged
  - ☐ No oil pressure enters drum.
  - ☐ Spring(s) holds piston away from clutch discs/plates.
  - ☐ Input shaft turns clutch hub and driving discs, but driven plates and drum remain stationary.
- Engaged
  - ☐ Oil pressure is routed to clutch drum.
  - ☐ Oil pressure forces piston into clutch discs, locking them together, forcing them into pressure plate, and thus transferring power through clutch assembly to the drum.

    ☑ **NOTE:** When power transfer is complete, the discs, plates, hub, and drum turn as a unit.
  - ☐ When clutch is released, oil pressure decreases, allowing piston return spring(s) to release its tension and push clutch plates and discs apart.

OBJECTIVE 5

Optional Activities/ Resources in Instructor's Guide

Explain the importance of clutch pack clearances.

- Friction disc to clutch plate disengaged clearance is generally a mere 0.010 inch per friction side.

- Both plates and friction discs must be perfectly true; a warped or bent clutch plate reduces clutch pack life.

- When the clutch pack is too tight, clutches can bind and wear out prematurely.

- Excess clearance causes rough engagements, engine flare-ups, and premature wear.

- Manufacturers use different methods of obtaining clutch pack clearances; it is important to pay close attention to the method specified by the manufacturer.

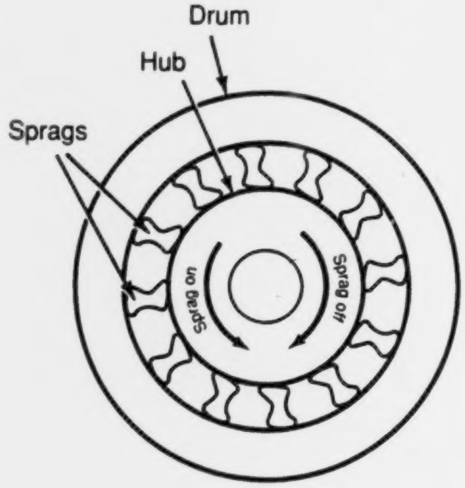
OBJECTIVE 6

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Label the parts of a sprag clutch.

FIGURE 6



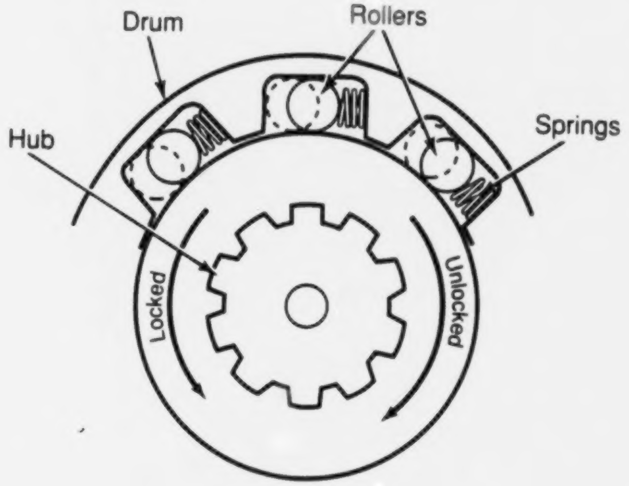
OBJECTIVE 7

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Label the parts of a roller clutch.

FIGURE 7



OBJECTIVE 8

Optional Activities/
Resources in
Instructor's Guide

Explain how sprag and roller clutches work.

WORDS YOU SHOULD KNOW	
one-way clutch	mechanical holding device that prevents rotation in one direction, but overruns to allow rotation in other direction
cam-cut drum	one-way roller clutch drum with an inner surface machined with a series of angled grooves into which the rollers wedge (may be either inner or outer race)

- Sprag clutch
  - ☐ The sprag clutch allows one-way hub rotation at all times.

    ☑ **NOTE:** For the clarity of this explanation of sprag clutch operation, allowed one-way hub rotation will be designated as clockwise.

- ☐ When the clutch hub rotates clockwise, the sprags tilt and open a space between themselves, the hub, and the drum.
- ☐ This action unlocks the clutch and allows the hub to freewheel.
- ☐ When the drum is held, the moment the hub rotates counterclockwise, the sprags tilt the other way and wedge between the hub and drum, locking the clutch.

- Roller clutch

  - ☐ The roller clutch allows clockwise hub rotation at all times.

    ☑ **NOTE:** For the clarity of this explanation of roller clutch operation, allowed one-way hub rotation will be designated as clockwise.

  - ☐ When the clutch hub rotates clockwise, the rollers move toward the large ends of the cam-cut drum pockets, compressing the springs.
  - ☐ This action unlocks the clutch and allows the hub to freewheel.
  - ☐ When the clutch drum is held, the moment the hub rotates counterclockwise, the rollers (with the help of released spring tension) wedge into the small ends of the drum pockets, locking the clutch.

OBJECTIVE 9

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Label the parts of a typical band/servo assembly.

Your instructor will display a typical band/servo assembly or its components. You must be able to label the following parts:

- Anchor pin
- Brake band
- Band actuating rod
- Band release spring
- Damping spring
- Piston seal
- Snap ring
- Servo piston
- Servo pressure chamber
- Band adjusting screw
- Locknut
- Servo cover
- Automatic transmission case

OBJECTIVE 10

Required Activities/
Resources in
Instructor's Guide

State the functions of band and servo components.

- **band** — stopping drum rotation
- **band lining** — providing friction

  ☑ **NOTE:** The friction material that lines the band is designed to operate in automatic transmission fluid and still provide needed friction. It resists the lubricating qualities of the fluid.

- **servo piston** — transferring force to activating rod
- **actuating rod** — pushing on band to squeeze it inward on drum

- **band adjustment screw** — adjusting band-to-drum clearance

  ☑ **NOTE:** The adjustment screw moves the band closer to the drum as the friction material wears. Late model servo assemblies are adjusted by changing the apply pin length.

- **servo piston seals** — preventing fluid leakage around the servo piston and cylinder

- **snap rings** — holding the piston in its cylinder

OBJECTIVE 11

Optional Activities/
Resources in
Instructor's Guide

State the functions of internal and external coolers.

Internal and external coolers prevent automatic transmission damage by cooling transmission fluid that has been heated by the actions of the torque converter, gears, and shafts; and return cooled transmission fluid to the transmission.

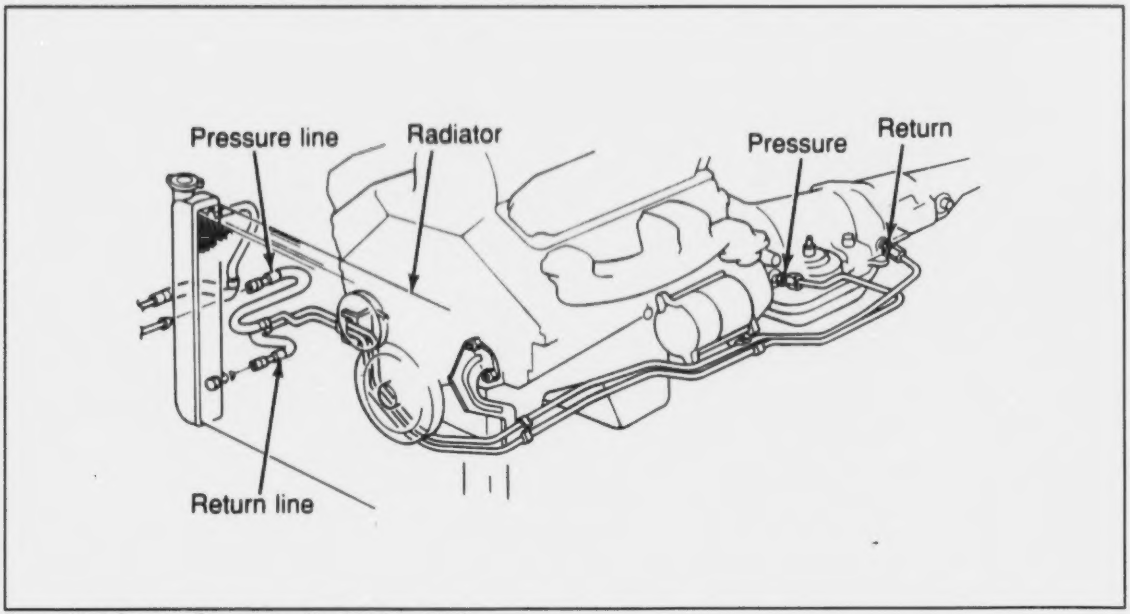
OBJECTIVE 12

Required Activities/
Resources in
Instructor's Guide

Distinguish between descriptions of internal and external coolers.

- **internal cooler** — a small sealed heat exchanger in the lower tank of downflow radiators or the outlet tank of crossflow radiators (Figure 8)

FIGURE 8



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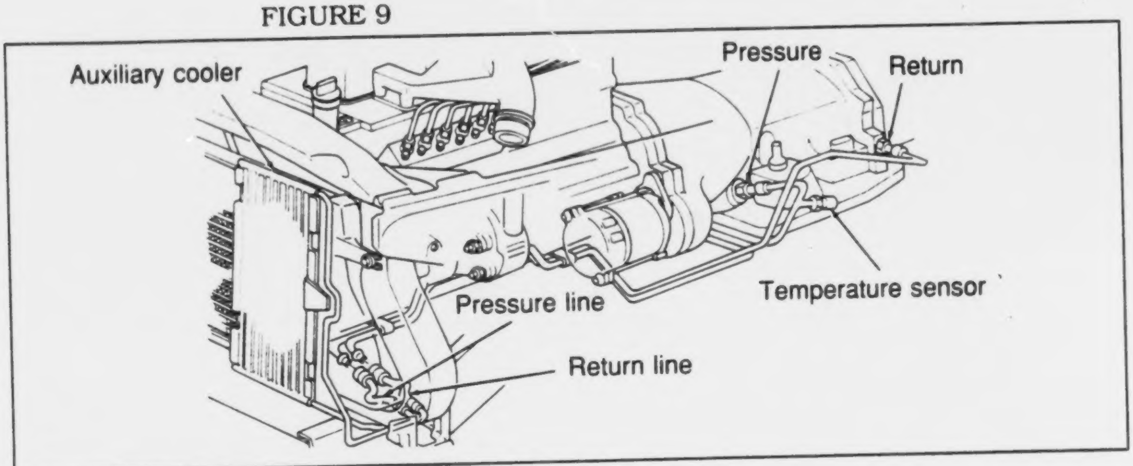
- **external cooler** — a separate, small transmission radiator outside the engine radiator; cools transmission fluid on vehicles subject to heavy loads; heated fluid runs first through internal cooler and then through external cooler (Figure 9)

FIGURE 9



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OBJECTIVES 13-21

Complete Job Sheets 1 - 9.

JOB SHEET 1

SERVICING FRICTION UNITS AND COOLER

6

Name ______________________________

OBJECTIVE 13

Disassemble, inspect, replace, and reassemble multiple-disc clutch assembly.

INTRODUCTION

Multiple-disc clutches are used to hold or drive a planetary gear member. They are hydraulically applied. Transmissions contain several multiple-disc clutches. Because of variations in construction and design, however, it is necessary to use clutch-specific procedures and tools when removing, inspecting, servicing, and replacing or reinstalling automatic transmission multiple-disc clutch assemblies.

Guidelines

- Check clutch pack plates and discs. Both plates and friction discs must be perfectly true; a warped or bent clutch plate reduces clutch pack life.
- Remove friction discs and clutch plates from the drum and wipe them with a clean, lint-free cloth. Do not wash friction discs and dry them with compressed air; *the force of the compressed air lifts the friction material off the plate.*
- Inspect friction discs for the following defects:
    - ☐ Excessive wear
    - ☐ Cracked lining material
    - ☐ Charred, burned, or glazed lining surface
    - ☐ Pitting, flaking, or scoring
    - ☐ Chips or particles embedded in lining
    - ☐ Scoring or burns on disc serrations
    - ☐ Distortion
    - ☐ Easy fit in clutch hub serrations
    - ☐ Worn or damaged splines

- If any friction disc is defective, replace the entire clutch pack.
- Inspect clutch plates for the following defects:
  - ☐ Uneven heat discoloration
  - ☐ Surface scuffing or scoring
  - ☐ Damaged drive lugs
  - ☐ Fit in clutch hub serrations (should fit freely)
  - ☐ Distortion
- If none of the discs and plates is defective, loop the snap ring through them to keep the original snap ring and clutch pack together in the proper order.
- Check with your vehicle service manual for recommended practice for soaking clutch pack in ATF.

  ☑ **NOTE:** Many automatic transmission specialists recommend soaking the clutch pack for 30 minutes in a tray of ATF.
- Check for broken, distorted, or collapsed springs. If one or more springs require replacement, discard them all and install a complete new set of springs.

EQUIPMENT AND SUPPLIES

- Automatic transmission
- Eye protection
- Basic hand tool set
- Appropriate automatic transmission overhaul kit
- Solvent
- Lint-free shop cloths
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	___	___
2. Followed applicable Job Sheet guidelines and service manual instructions for disassembly.	___	___
3. Inspected clutch discs and plates and clutch housing for wear and damage.	___	___
4. Replaced any damaged parts.	___	___
5. Followed applicable Job Sheet guidelines and service manual instructions for reassembly.	___	___
6. Followed all safety procedures.	___	___

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 2

SERVICING FRICTION UNITS AND COOLER

6

Name ______________________________

OBJECTIVE 14

Measure and adjust clutch pack clearance.

INTRODUCTION

One of the advantages of the multiple-disc clutch is that when it is assembled, its clearance is adjusted. There is no further need for clutch pack clearance adjustment until the transmission is again disassembled.

Three methods can be used for adjusting multiple-disc clutch pack clearance when reassembling a clutch: manipulating the outer snap ring thickness, manipulating the outer snap ring and inner plate thicknesses, or manipulating the clutch pressure plate thickness.

EQUIPMENT AND SUPPLIES

- Multiple-disc clutch assembly
- Eye protection
- Basic hand tool set
- Feeler gauge
- Appropriate automatic transmission overhaul kit
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Adjust clearance (outer snap ring method).	Yes	No
1. Install clutch pack and pressure plate.	____	____
2. Use feeler gauge to check against specifications the distance between pressure plate and outer snap ring.	____	____
3. If clearance is greater than specified, install a *thicker* snap ring to take up clearance.	____	____

Functional Math
- Make measurements

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

4. If clearance is not great enough, install a *thinner* snap ring to increase clearance. ____ ____

☑ **NOTE:** On vehicles having a wave-type outer snap ring, place the feeler gauge between the flat pressure plate and the wave in the snap ring farthest from the pressure plate.

PROCEDURE

Adjust clearance (combination outer snap ring and steel clutch plate method).

1. Install clutch pack and pressure plate. ____ ____
2. Use feeler gauge to check against specifications the distance between pressure plate and outer snap ring. ____ ____
3. If clearance is greater than specified, install *thicker* clutch plates in clutch pack and a *thicker* outer snap ring to take up clearance. ____ ____
4. If clearance is not great enough, install *thinner* clutch plates in clutch pack and a *thinner* outer snap ring to increase clearance. ____ ____

PROCEDURE

Adjust clearance (varying clutch pressure plate method).

	Yes	No
1. Install clutch pack and pressure plate.	____	____
2. Use feeler gauge to check against specifications the distance between pressure plate and outer snap ring.	____	____
3. If clearance is greater than specified, install *thicker* pressure plate to take up clearance.	____	____
4. If clearance is not great enough, install *thinner* pressure plate to increase clearance.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 3

SERVICING FRICTION UNITS AND COOLER

6

Name ______________________________

OBJECTIVE 15

Air test clutch pack and internal servo assemblies.

INTRODUCTION

The source of an automatic transmission hydraulic problem can be difficult to locate. Air tests simplify the process. When performing an air test, the technician applies air pressure (rather than hydraulic pressure) to case holes and passages leading to apply devices. Correct operation of clutches can be heard or felt.

If road and pressure testing indicate a slipping clutch or band, air pressure tests can be made. Air pressure tests can determine whether the problem is in the apply device itself or in the valve body that supplies hydraulic pressure. Air pressure tests are also conducted during overhaul disassembly to find leaking seals, and during reassembly to check for proper clutch and servo operation.

EQUIPMENT AND SUPPLIES

- Overhauled front and rear clutches and pump assembly
- Eye protection
- Basic hand tool set
- Bench vise
- Compressed air gun with conical nozzle
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Yes No

1. Assemble the front and rear clutches for air testing.

- Place the pump assembly—complete with reaction shaft support—over the turbine (input) shaft. ____ ____

☑ **NOTE:** Some—such as FWD vehicles—may require a different procedure. Refer to your service manual.

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
• Slide the pump assembly down into place on the front clutch drum.	____	____
2. Invert the whole assembly, and place carefully *on* an open bench vise.	____	____
3. Adjust compressed air to a pressure of approximately 25 psi.	____	____
4. Blow this reduced compressed air into each hole in pump housing, turning the housing so that the hole being tested is over the open area of the bench vise.	____	____

☑ **NOTE:** You should hear a solid "thud" with little or no air seepage.

⚠ **NOTICE:** When air is blown into the clutch drums, the two clutch assemblies may separate. Place a hand on top of the rear clutch assembly to prevent such separation.

	Yes	No
5. Use short 2- to 3-second bursts, and blow only until a thud is heard (the clutch applies).	____	____

☑ **NOTE:** When you release the air, the clutch releases. You can assume that if the clutch applies with air pressure, it will apply with fluid pressure. Once you have air tested, the complete pump assembly, front clutch, and rear clutch can be considered reconditioned and set aside until needed for assembling the transaxle/transmission.

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB SHEET 4

SERVICING FRICTION UNITS AND COOLER

6

Name ____

OBJECTIVE 16 **Inspect and replace sprag and roller clutches.**

INTRODUCTION

Sprag and roller clutches are the two types of overrunning or one-way clutches used in automatic transmissions. They control (hold or drive) the planetary gear train and are mechanically applied rather than hydraulically engaged as are multiple-disc clutches. Some four-speed overdrive automatic transaxles and transmissions may have two or three overrunning clutch assemblies of either the sprag or roller clutch design.

EQUIPMENT AND SUPPLIES

- Overhauled sprag and roller clutches
- Eye protection
- Basic hand tool set
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Inspect roller/sprag clutch.

1. Inspect one-way clutches for the following defects:

	Yes	No
• Excessively worn or damaged rollers on sprags and springs	____	____
• Bent or damaged spring retainers in sprag clutch assemblies	____	____
• Flat spots or chipped edges on clutch rollers	____	____
• Dents or grooves (brinelling) on roller contact surfaces of clutch races	____	____
• Distorted snap rings	____	____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities

- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development

- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

- Plugged or restricted lubrication holes in inner clutch races ____ ____

☑ **NOTE:** If any part of the clutch is damaged, the entire clutch assembly should be replaced with a new one.

PROCEDURE

Replace roller clutch.

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

1. Referred to appropriate service manual. ____ ____
2. Inspected clutch for defects. ____ ____
3. Replaced clutch according to service manual instructions and cautions. ____ ____
4. Followed all safety procedures. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB
SHEET 5

SERVICING FRICTION UNITS AND COOLER

6

Name ______________________________

OBJECTIVE 17

Inspect and adjust bands and replace or refinish drums.

INTRODUCTION

In order for a transmission to operate properly, all components must be correctly adjusted. Some components, such as clutches, cannot be adjusted if they wear beyond their limits. They must be rebuilt. Bands, however, can usually be adjusted. Band adjustment helps keep the transmission points crisp and on time.

Bands can be adjusted as part of in-vehicle service or as part of transmission overhaul. Most bands on late units can only be adjusted during overhaul or by replacing servo pins. On older models, bands are adjusted with an adjusting screw.

The surface that bands contact must also be prepared. Use the following guidelines for preparing drums and hubs:

- Check the surface carefully.
- If it is grooved or scored, discard the drum; if it is glazed, some manufacturers recommend refinishing or replacing the drum.
- **Do not** refinish Torqueflite® drums. Sanding may cause filter blockage after initial startup. **Do not** refinish 700R-4 drums. Shift quality may be affected.

EQUIPMENT AND SUPPLIES

- Automatic transmission bands
- Eye protection
- Basic hand tool set
- Appropriate service manual
- 8-point, 5/16-inch square socket
- Allen wrench or 6-point socket
- Torque wrench (1-4-inch drive)
- 120-180-grit sandpaper
- Other equipment and materials as required by procedure

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Inspect bands.

	Yes	No
1. Wipe each band clean with a dry, lint-free cloth.	___	___

⚠ **NOTICE:** Do not force open thin flex-type bands any farther than their normal relaxed position. If you open them beyond that point, the lining friction material may crack.

	Yes	No
2. Inspect band for the following defects, paying particular attention to the ends—they tend to wear more there because they apply there first. Look for:		
• Distortion	___	___
• Discolored or checked lining	___	___
• Cracked ends	___	___
• Excessive or uneven wear	___	___
• Burn marks, charring, or glazed surfaces	___	___
• Poor lining bond to band	___	___
• Flaking and pitting (scratch lining surface with your thumbnail; if lining material builds up on top of your nail, replace the band)	___	___
• Chips or particles embedded in lining	___	___
• Distortion of apply strut (if used)	___	___
3. Replace any defective band with a new one.	___	___
4. Before installing, soak new bands in ATF for length of time recommended in service manual.	___	___

☑ **NOTE:** Many automatic transmission specialists recommend soaking the clutch pack for 30 minutes in a tray of ATF.

	Yes	No
5. Follow service manual instructions for installation.	____	____

PROCEDURE

Adjust bands and replace or refinish drums.

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	____	____
2. Inspected band, lining, and strut for defects.	____	____
3. Replaced defective band with new one, following service manual instructions.	____	____
4. Soaked bands in ATF according to service manual time specifications.	____	____
5. Replaced grooved or scored drums.	____	____
6. Followed manufacturer's specifications for refinishing glazed drums.	____	____
7. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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JOB SHEET 6

SERVICING FRICTION UNITS AND COOLER

6

Name ______________________________

OBJECTIVE 18

Leak-test and service cooler and lines.

INTRODUCTION

The engine cooling system is key to proper transmission cooling when an internal cooler is used. If anything affects engine cooling, it will also affect transmission cooling. The cooling system must always be inspected and properly maintained.

Looking for leaks, or potential leaks, is the main concern when visually inspecting the transmission cooling system. If it is suspected that the transmission cooler core in the engine's radiator is leaking, it can be double-checked with a leak test.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Basic hand tool set
- Cooler flushing machine and instruction booklet
- Approved transmission fluid
- Approved coolant
- Cooler fitting plug
- Hand air-pressure pump or shop air supply
- Shop towels
- Waste-oil container
- Appropriate lengths of hose for cooler outlets
- Cleaning solvent recommended by flushing-machine manufacturer or vehicle service manual
- Length of high-grade, high-temperature reinforced flexible hose to connect tubing to cooler fitting (if applicable)
- Length of string
- Rule
- New hose clamps
- Tubing cutter
- Tubing reamer
- Tubing bender

- Flaring tool
- Seamless or double-wrapped brazed-steel replacement tubing
- Replacement-hose clamps

☑ **NOTE:** Do not use copper or aluminum tubing. These metals are soft and cannot withstand the flexing that occurs with normal car vibrations. *Flexing* causes the soft tubing to become brittle and to crack and leak.

PROCEDURE

Inspect cooler and lines.	Yes	No
1. Check potential leak areas: fluid lines and fittings between transmission and cooler.	____	____
2. Inspect engine coolant in radiator; if there is transmission fluid in the coolant, the fluid cooler is leaking.	____	____
3. Check the transmission dipstick for signs of engine coolant; if fluid is milky pink, coolant is leaking into the transmission.	____	____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Functional Math
- Make measurements

Cognitive Activities
- Transfer knowledge/training to new situations

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

PROCEDURE

Leak-test cooler. Yes No

1. Disconnect and cap transmission-to-cooler lines at radiator. ____ ____
2. Remove radiator cap to relieve cooling-system pressure from outside of cooler. ____ ____
3. Tightly plug one cooler fitting. ____ ____
4. Attach air-pressure line from shop air supply or hand pump to other cooler fitting. ____ ____
5. Apply 50- to 75-psi air pressure. ____ ____
6. Check coolant for air bubbles. ____ ____

   ☑ **NOTE:** If air bubbles are present, the cooler does not hold pressure and must be repaired or replaced.

7. Examine transmission fluid color and condition. ____ ____

   ☑ **NOTE:** If transmission fluid is milky pink, coolant is leaking into the transmission.

PROCEDURE

Flush and clean cooler.

1. Read flushing-machine instruction booklet. ____ ____
2. Connect flushing-machine lines to the cooler lines, following directions in flushing-machine instruction booklet. ____ ____
3. Place inlet hose in a suitable container. ____ ____
4. Apply air from machine in short blasts, allowing cooler to fill between blasts. ____ ____

   ☑ **NOTE:** Some flushing machines automatically apply air in short blasts.

5. Continue procedure until solvent runs clear from cooler inlet hose. ____ ____

	Yes	No
6. Shut off solvent flow, following directions in flushing-machine instruction booklet.	____	____
7. Dry the cooler by applying air in short, intermittent blasts.	____	____
8. Pump a pint of appropriate transmission fluid into cooler.	____	____
9. Apply air from the machine in short blasts until all fluid has been forced from cooler.	____	____
10. Disconnect flushing machine from cooler lines.	____	____
11. Reconnect cooler lines.	____	____

PROCEDURE

Make and replace metal cooler lines.

☑ **NOTE:** You should not attempt to repair a damaged cooler line. Instead, you should replace the entire line.

1. Measure damaged length of tubing as accurately as possible.	____	____

☑ **NOTE:** Use a length of string and then measure the string.

2. Use tubing cutter to cut a section of new tubing to the length measured in Step 1.	____	____
3. Ream one cut end of new tubing with tubing reamer.	____	____
4. Use tubing bender to shape new tubing to that of old tubing; use old tubing as a model.	____	____
5. Recheck length, and cut to size as necessary.	____	____

☑ **NOTE:** When formed to the shape of the damaged line, the new tubing may be slightly longer than the old.

6. Ream other end of tubing.	____	____

	Yes	No
7. Install the necessary fitting on each end of tubing.	____	____
8. Using flaring tool and following its instruction booklet, perform the two steps necessary to double-flare one end of tubing.	____	____
9. Double-flare remaining end of tubing, repeating Step 8.	____	____
10. Position the new line loosely under existing clamps on engine or chassis.	____	____
11. Connect each end of line and torque fitting to specifications.	____	____
12. Tighten mounting clamps.	____	____
13. Run engine at idle and check for leaks.	____	____

PROCEDURE

Replace damaged section of flexible hose.

1. Measure old length of flexible hose.	____	____
2. Cut new hose to measured length.	____	____
3. Install new hose so that it fits flush against radiator at one end and extends at least 2 inches over flared end of tubing at other end.	____	____
4. Secure hose with new clamps.	____	____
5. Tighten clamps to manufacturer's recommended specifications.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 Skilled — Can perform job with no additional training
3 Moderately Skilled — Has performed job during training program; limited additional training may be required
2 Limited Skill — Has performed job during training program; additional training is required to develop skill
1 Unskilled — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB SHEET 7

SERVICING FRICTION UNITS AND COOLER

6

Name ________________________________

OBJECTIVE 19 **Measure cooler flow rate.**

INTRODUCTION

Cooler flow should be continuous and liberal. An unsatisfactory cooler-fluid flow rate indicates a defective oil pump, a main circuit system leak, or a cooler restriction.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Appropriate service manual
- Eye protection
- Basic hand tool set
- 1-quart (or larger) funnel
- Approved transmission fluid
- Approved coolant
- Cooler fitting plug
- Hand air-pressure pump or shop air supply
- Shop towels

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

	Yes	No
1. Start the engine and bring the transmission to normal operating temperature.	____	____
2. Shut off the engine.	____	____
3. Check the transmission fluid level; adjust to full as necessary.	____	____
4. Remove the dipstick from the filler tube, and install a 1-quart funnel in its place.	____	____
5. Safely raise vehicle to proper working height on hoist.	____	____

Cognitive Activities
- Transfer knowledge/training to new situations

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
6. Disconnect cooler return line at transmission.	____	____
7. Connect one end of length of hose to disconnected cooler line.	____	____
8. Insert other end in the funnel.	____	____
9. Start the engine and run it at 1,000 rpm with the transmission in *Neutral.*	____	____
10. Watch the fluid flow at the funnel; once the air has bled from the system, flow should be continuous and liberal.	____	____
11. If flow rate is not satisfactory and a leak is suspected, look for anything restricting cooler, lines, pump, or case.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1

Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

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JOB SHEET 8
SERVICING FRICTION UNITS AND COOLER

Name ______________________________

OBJECTIVE 20 **Reassemble transmission.**

INTRODUCTION

Clutches, bands, gearsets, bearings, and thrust washers are parts and subassemblies that are assembled as part of transmission reassembly. Some are partly assembled before being installed in the transmission case, others are installed as partial assemblies, and external assemblies such as servos, accumulators, and governors are often replaced as complete units. Therefore, it is important that you follow service manual procedures for your particular transmission.

Guidelines

- Before beginning to reassemble the transmission, air check any parts that have not already been air checked for operation and leaks.
- Reassemble each assembly, set it aside, and continue on with the next until all subassemblies are finished.
- Air test clutch and band application before installing valve body.

⚠ **CAUTION:** Always wear eye protection when using compressed air.

- When assembling the clutches for air testing, let *gravity* work for you. Align the front clutch drum over the hub and slowly rotate the clutch drum back and forth to allow each friction disc to align with the splines on the front clutch hub. The assembly will drop as the inside diameter teeth align with the splines on the clutch hub. When the clutch drum drops into place with a thud, the clutch drum is installed.

- Avoid using force when reassembling or installing parts into the transmission case. You may have to twist or rotate a part in order to seat or mesh it, but *force is never required.* If there seems to be no other way to reassemble the part, you have made an error in assembly, used an incorrect snap ring or thrust washer, or installed parts in the wrong order.

- Before reassembly, soak all bands, clutches, and steel clutch plates in clean ATF for the time specified in the service manual.

  ☑ **NOTE:** Many automatic transmission specialists recommend soaking the clutch pack for 30 minutes in a tray of ATF.

- Coat metal components with automatic transmission fluid.

- When installing rubber seals, make sure that the lip points *toward* the pressure source.

- Torque all bolts to service manual specifications.

- When torquing valve bodies and transfer plates, work *from the center outward* to prevent possible distortion of mating surfaces.

- Check end play in input and output shafts; adjust as necessary by changing thrust washer thickness.

- When necessary, check internal clearances against service manual specifications.

- Make sure that all snap rings are securely seated in their grooves.

- Once you have completely reassembled the transmission, determine whether a new torque converter is needed and order it if necessary.

- Replace the torque converter if necessary. Install the converter over the stator support and input shaft, making sure that it is seated on the oil pump drive lugs.

EQUIPMENT AND SUPPLIES

- Reconditioned transmission components
- Eye protection
- Basic hand tool set
- Appropriate measuring equipment
- Recommended automatic transmission fluid
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Referred to appropriate service manual.	____	____
2. Air tested all applicable components for operation and leaks.	____	____
3. Reassembled each assembly according to service manual instructions, set it aside, and continued with the next until all subassemblies were finished.	____	____
4. Avoided using force when reassembling or installing parts into the transmission case.	____	____
5. Before reassembling, soaked all bands, clutches, steel clutch plates, and metal parts in clean ATF for length of time specified in service manual.	____	____
6. Torqued all bolts to service manual specifications.	____	____
7. Made accurate measurements when necessary and checked measurements against service manual specifications.	____	____
8. Followed all safety procedures.	____	____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Functional Math
- Make measurements

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

553

JOB SHEET 9

SERVICING FRICTION UNITS AND COOLER

Name ______________________________

OBJECTIVE 21 **Reinstall and adjust transmission.**

INTRODUCTION

Reinstalling a transmission is not quite the opposite of *removing* it. Merely to "reverse the procedure" is a dangerous oversimplification. There are usually slight but significant differences in the reassembly or installation process. If the technician is unaware of these differences, figuring out exactly what went wrong or why a component does not fit can be very frustrating.

One of the most difficult aspects of reinstalling a transmission is the tendency to want to finish up the job quickly. However, the technician must take the time to do the job right:

- If you performed a service that created particles of metal or friction material, take the time to flush the transmission cooler and its lines so that debris does not return to the transmission and cause it to fail again.
- During installation, work slowly and carefully to align the torque converter with the engine before bolting the transmission in place.
- When the linkage requires the use of cotter pins or nylon grommets, install new ones.
- Be sure to place any washers used in the linkage connections on the correct side of the levers or rods involved.
- Take the time to replace wiring harnesses and vacuum lines in their mounting clips.

Paying attention to such details not only saves time and money in the long run, it is the mark of a trained professional.

The general installation procedure that follows is sequentially based on the removal procedure you performed in Unit 3, Job Sheet 1; however, it includes the significant differences necessary to make the procedure accurate and effective.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Large drain pan
- Tilting-base transmission jack
- C-clamp
- Torque wrench
- Flywheel turner
- Safety strap or chain
- Replacement dipstick tube O-ring seal or gasket as required
- Replacement nylon grommets or cotter pins if used on mechanical linkages
- Shop towels
- Appropriate transmission fluid
- Pressure gauge
- Appropriate service manual
- Other equipment and materials as required by procedure

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Yes No

⚠ **NOTICE:** You must reinstall the transmission and converter at the same time and as a single unit to prevent damage to the converter flexplate, the pump housing, and the oil seal. The converter flexplate cannot support any weight. Take care to avoid resting any of the transmission's weight on the flexplate during installation.

---

1. Install and tighten converter drain plug if this was not done when removing the transmission from the vehicle. ____ ____
2. Transfer transmission case from workbench or support stand to transmission jack, strapping or chaining it securely in place. ____ ____
3. Install converter in transmission bellhousing, sliding it over stator support and into front pump. ____ ____

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
⚠ **NOTICE:** Be sure that the converter is all the way in. The converter hub must engage the inner rotor or gear lugs of the pump. Some manufacturers provide a measurement that shows correct converter installation. Check your service manual.		
4. If necessary, attach a small C-clamp to edge of bellhousing to prevent converter from slipping out of place.	____	____
5. Lubricate converter hub hole in crankshaft or flexplate.	____	____
6. Rotate converter to align drive lugs and drain plugs with their holes in the flywheel or flexplate, and to align index marks that you made on removal.	____	____
☑ **NOTE:** Some flywheels have a pilot hole to ensure proper alignment. If this is the case, index the converter with the pilot hole.	____	____
7. Tilt transmission on jack as necessary and raise it into position under vehicle.	____	____
8. Raise or lower jack as necessary to align bellhousing pilot holes with dowels in engine.	____	____
9. Check converter to make sure that it has not slipped out of place and that converter and flexplate marks are aligned.	____	____
10. Move transmission forward, working bellhousing over alignment dowel pins at rear of engine block.	____	____
⚠ **NOTICE:** Take care not to put any weight on the flexplate at this point.		
11. With transmission properly positioned, install bellhousing lower bolts, and tighten them to pull housing to engine.	____	____
12. Raise transmission slightly, and install bellhousing upper bolts.	____	____

Yes No

13. Torque upper and lower bolts to manufacturer's torque specifications. ____ ____

14. If you removed crossmember when removing the transmission from the vehicle, replace crossmember at rear of transmission:

    - Position crossmember at frame supports. ____ ____
    - Install and torque bolts to manufacturer's torque specifications. ____ ____

15. Lower transmission and bolt rear transmission mount to crossmember. ____ ____

16. Torque all bolts to manufacturer's torque specifications. ____ ____

17. Unfasten safety strap or chain from transmission, and remove jack. ____ ____

18. Connect flywheel or flexplate to converter:

    - Install first attaching bolt through pilot hole, if flywheel uses one. ____ ____

⚠ **NOTICE:** This step is necessary to prevent misalignment, which can result in transmission or flywheel failure.

- Install remaining converter attaching bolts with flywheel turner, *not* by turning converter. ____ ____

⚠ **NOTICE:** Turning the converter distorts the flexplate.

---

19. Reinstall converter access cover, torquing all bolts to manufacturer's torque specifications. ____ ____

20. Carefully reinstall dipstick filler tube, using a new O-ring seal or gasket as required, seating tube completely, and reinstalling all attachment bolts. ____ ____

	Yes	No
21. Position transmission cooler lines in retaining clip at engine block.	____	____
22. Connect lines to transmission case, using two wrenches—one to hold fitting and one to tighten tubing nut.	____	____
23. Reconnect speedometer cable to transmission.	____	____
24. Position wiring harnesses in their mounting clips (if clips are used) and connect all wires to their corresponding transmission switches.	____	____
25. Reconnect vacuum lines to modulator, reinstalling any mounting clips used.	____	____
26. Connect all mechanical linkages to transmission, installing new nylon grommets or cotter pins if used:		
• Snap new grommet into lever with pliers.	____	____
• Snap the rod into the grommet.	____	____
27. Replace starter motor, torquing attaching bolts to manufacturer's torque specifications.	____	____
28. Reconnect all electrical leads to starting motor and solenoid.	____	____
29. If you lowered the exhaust system for clearance, reconnect exhaust pipe to manifold, and tighten any other exhaust system hangers you may have loosened.	____	____
30. Reinstall drive shaft sliding yoke:		
• Wipe sliding yoke clean.	____	____
• Guide it into extension housing and onto output shaft splines.	____	____
• Align marks at rear.	____	____

Yes No

⚠ **NOTICE:** If the shaft is not installed exactly as it was removed, shaft runout will cause excessive vibration.

- Connect universal joint to companion flange. ____ ____

- Torque all bolts to manufacturer's torque specifications. ____ ____

31. Adjust all mechanical linkages to specifications as required. ____ ____

    ☑ **NOTE:** Refer to your service manual as necessary.

32. Lower vehicle, if on a hoist, and add correct fluid to transmission. ____ ____

    ☑ **NOTE:** Refer to Unit 2 and the service manual as necessary.

33. Reconnect any parts removed or disconnected under the hood (battery ground cable, throttle linkage, distributor cap and rotor, etc.) ____ ____

34. Inspect transmission, converter, and transmission cooler lines for leakage. ____ ____

35. Run engine until transmission is at normal operating temperature; then check transmission fluid level, and add fluid as needed to obtain correct level. ____ ____

    ☑ **NOTE:** Refer to Unit 2 and the service manual as necessary.

36. Conduct a pressure test:

    - Connect a pressure gauge or pressure gauges to pressure taps. ____ ____

    - Record pressures in each gear range. ____ ____

	Yes	No
• Compare these pressures with manufacturer's specifications, and correct any deficiencies so that incorrect pressure does not damage newly installed transmission.	____	____
37. Road test vehicle to check transmission operation.	____	____
38. Make any necessary adjustments to linkage, and recheck fluid level.	____	____
39. Clean work area, and return equipment and materials to proper storage.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

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Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1

Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

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3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

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OBJECTIVE SHEET

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

INTRODUCTION

Front-wheel drive vehicles have gained popularity in the last several years because their design provides improved traction and increased fuel economy over rear-wheel drive vehicles. Front-wheel drive design is also lightweight and compact, so does not sacrifice interior room.

PREREQUISITES

Introduction to Automotive Service: Automatic Transmission/ Transaxle Specialist, Unit 3, "Servicing Rear-Wheel Drive Transmissions"

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS

PREREADING:	Read the section in your textbook that introduces you to transaxles and explains the differences between front-wheel drive transaxles and rear-wheel drive transmissions. Study the illustrations, and pay particular attention to the sections on shop practices and jack safety. Read the sections on transaxle removal, disassembly, and cleaning in the service manual for the vehicle on which you will be working. Pay particular attention to service tips, cautions, and warnings.
WRITING:	Write a list of cautions and warnings associated with transaxle removal, disassembly, and cleaning. Make each item in the list a complete sentence.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Answer questions about the characteristics of a front-wheel drive automatic transmission/transaxle.
2. Label the parts of a typical gearshift linkage on a front-wheel drive transaxle.
3. Describe the functions of various types of automatic transaxle linkages and controls.
4. State the function of the transaxle drive link assembly.
5. Label the parts of a transaxle drive link assembly.
6. Identify wear points of a transaxle drive link assembly.
7. Label the parts of a typical FWD axle shaft assembly.
8. Label the parts of a typical final drive and differential assembly.
9. Identify final drive arrangements and gear types.
10. Replace external seals and gaskets. (Job Sheet 1)
11. Remove transaxle. (Job Sheet 2)
12. Disassemble and clean transaxle. (Job Sheet 3)
13. Inspect converter flexplate assembly. (Job Sheet 4)
14. Inspect transaxle drive link assembly. (Job Sheet 5)
15. Inspect transaxle final drive components. (Job Sheet 6)

INFORMATION SHEET

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

OBJECTIVE 1

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Answer questions about the characteristics of a front-wheel drive automatic transmission/transaxle.

WORDS YOU SHOULD KNOW

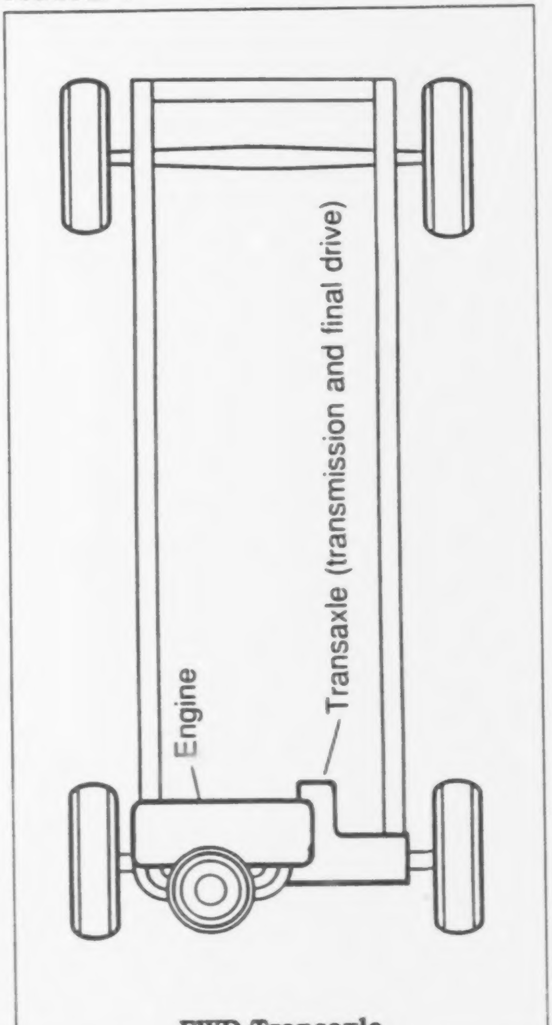
differential	gearset that permits two axles to operate at different speeds

EXAMPLE: When a vehicle turns a corner, the outer wheels rotate more times than the inner wheels because they travel farther. The differential gearset splits the drive torque to compensate for this difference.

halfshafts	short drive shafts used to transmit torque from the transaxle/transmission to the driven wheels of a front-wheel drive vehicle
pinion gear	small gear either driven by or driving a larger gear
ring gear	large gear attached to the differential carrier
splined	joined when metal splines (lands) on one part slide into grooves between splines on another part
transaxle	drive setup in which the transmission and final drive are combined into a single unit

☑ **NOTE:** The main difference between a transaxle and a transmission is that the differential and transmission of a transaxle are inside the same housing (Figures 1 and 2). Because there is no driveshaft, the differential ring gear is driven directly off the output shaft of the transmission.

FIGURE 1



FWD Transaxle

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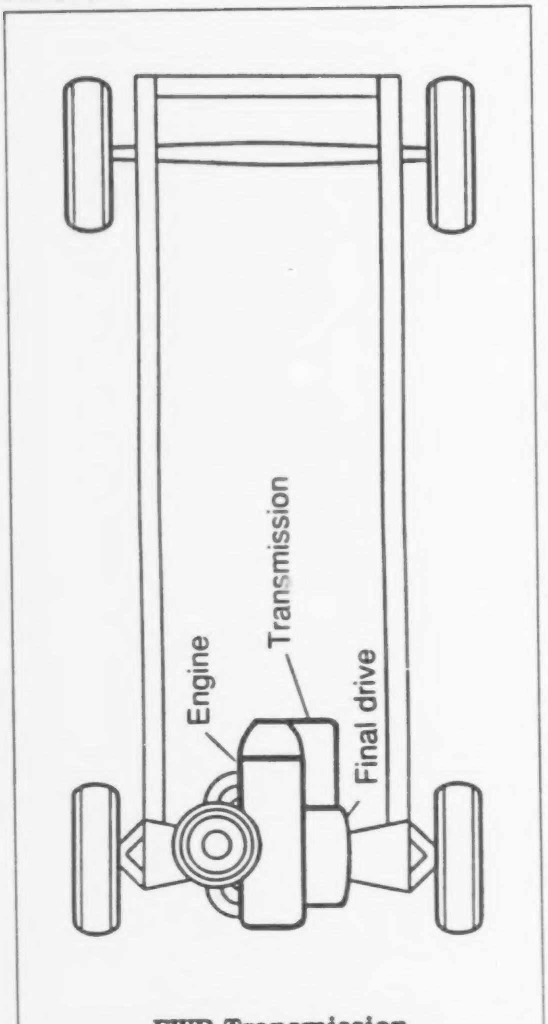
FIGURE 2



FWD Transmission

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- Two driving axles (halfshafts) connect the transaxle to the front wheels.
- The FWD vehicle is pulled when torque is transferred from the transaxle output shaft to the final drive ring gear.
- The drive ring gear drives the pinion gears against side gears splined to the front drive axles, which drive the wheels.
- FWD design is lightweight and compact so does not sacrifice interior room.

- FWD design promotes improved traction and increased fuel economy over rear-wheel drive vehicles.

OBJECTIVE 2

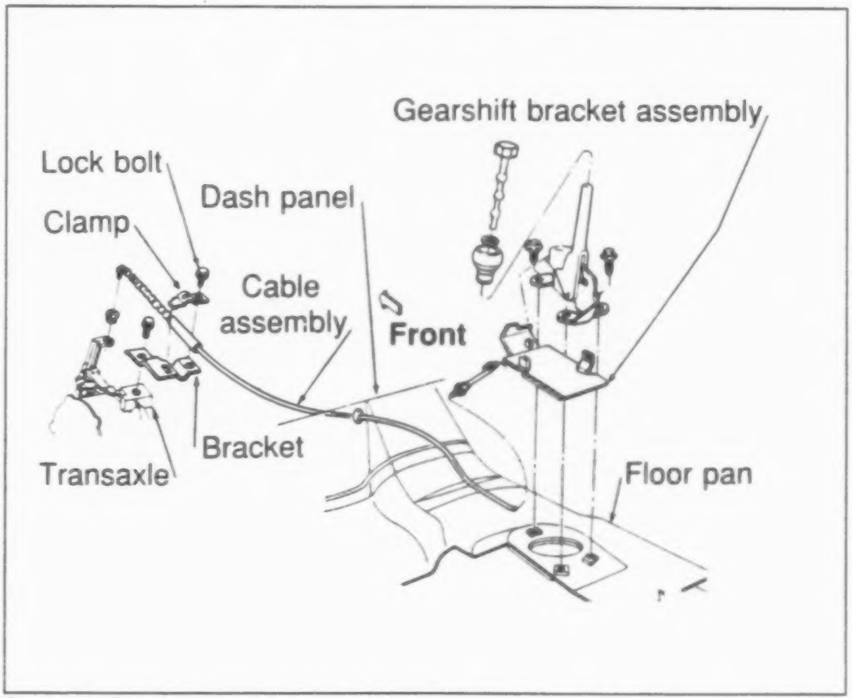
Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Label the parts of a typical gearshift linkage on a front-wheel drive transaxle.

☑ **NOTE:** Adjustment is made at transaxle end of cable.

FIGURE 3



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OBJECTIVE 3

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Describe the functions of various types of automatic transaxle linkages and controls.

WORDS YOU SHOULD KNOW	
kickdown	system in automatic transmission that produces a downshift when the accelerator is pushed abruptly to the floorboard as for passing
linkage	a series of rods or cables that transmit motion
throttle valve	sends hydraulic torque signal to shift valve body to control shifting in relation to engine torque
WOT	wide-open throttle position with the accelerator pressed to the floorboard; also called *full throttle*

- **throttle linkage** — signals engine load to the transaxle; sometimes called the *throttle valve (TV) linkage;* may be solid rod or cable

- **manual shift linkage** — transmits driver's vehicle direction and gear selection commands to the manual control valve; sometimes called *gearshift linkage*, *manual linkage*, or *shift linkage*; may be solid rod or cable

- **kickdown linkage** — permits driver to obtain a downshift

- **neutral safety switch** — prevents engine from cranking in any gear but neutral or park; on transaxles equipped with electronically controlled converter clutches, it also sends a signal to the computer; sometimes called a *neutral start switch*

  ☑ **NOTE:** While the neutral safety switch is not usually thought of as a linkage adjustment, it should not be overlooked. Starting in a drive range can be dangerous.

- **vacuum regulator valve** — controls shift points by sending vacuum signal to the transaxle on some vehicles equipped with a diesel engine

  ☑ **NOTE:** Most diesels need a separate vacuum pump to supply the various systems with vacuum. The vacuum regulator valve is usually mounted on the injection pump.

OBJECTIVE 4

Required Activities/
Resources in
Instructor's Guide

State the function of the transaxle drive link assembly.

- Connecting the engine to the transmission

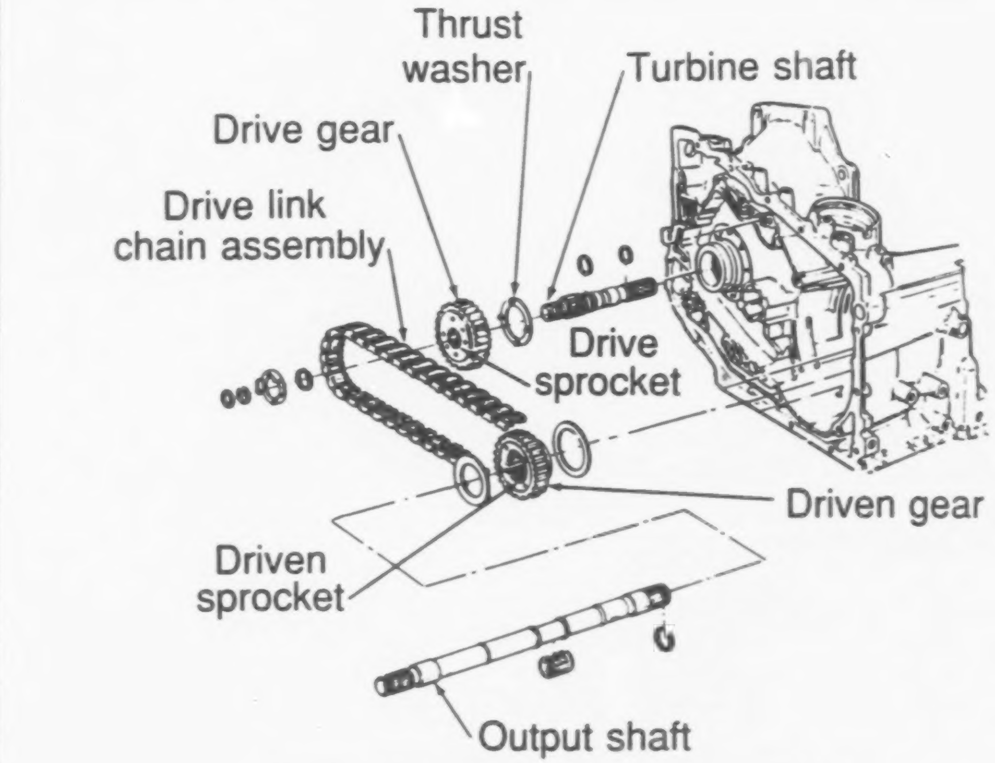
OBJECTIVE 5

Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

Label the parts of a transaxle drive link assembly.

FIGURE 4



General Motors 4T60 Drive Link Assembly

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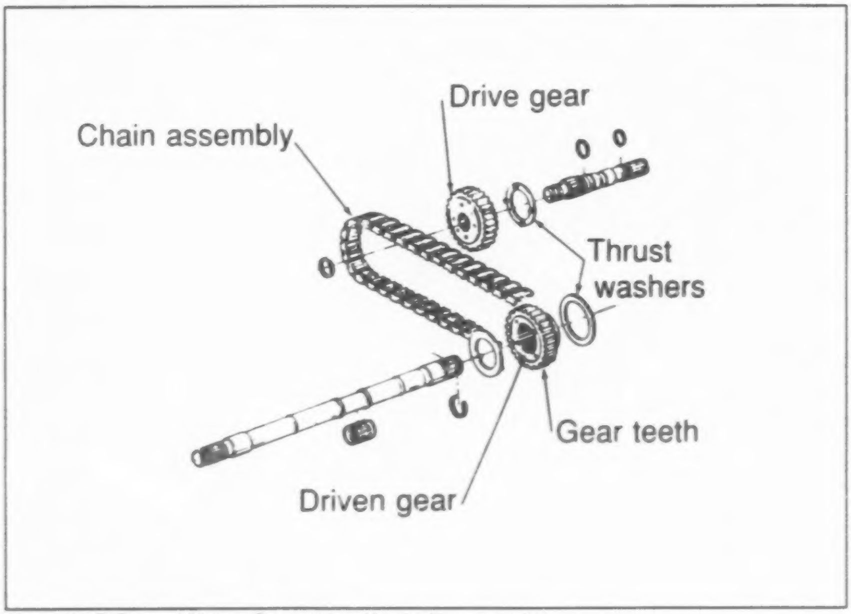
OBJECTIVE 6

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Identify wear points of a transaxle drive link assembly.

FIGURE 5



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OBJECTIVE 7

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

Label the parts of a typical FWD axle shaft assembly.

☑ **NOTE:** Axle shaft assemblies are three-piece units consisting of an outer joint, a connecting shaft, and an inner joint (Figures 6 and 7). A separate axle shaft is used for each driving wheel. Depending on the model, the axle shafts may be equal or unequal in length.

FIGURE 6

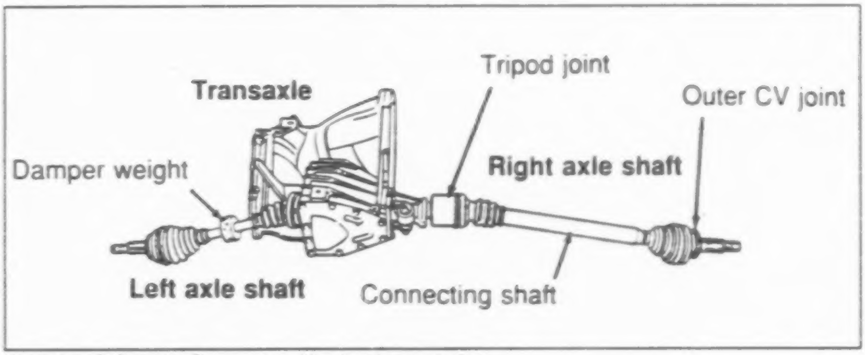

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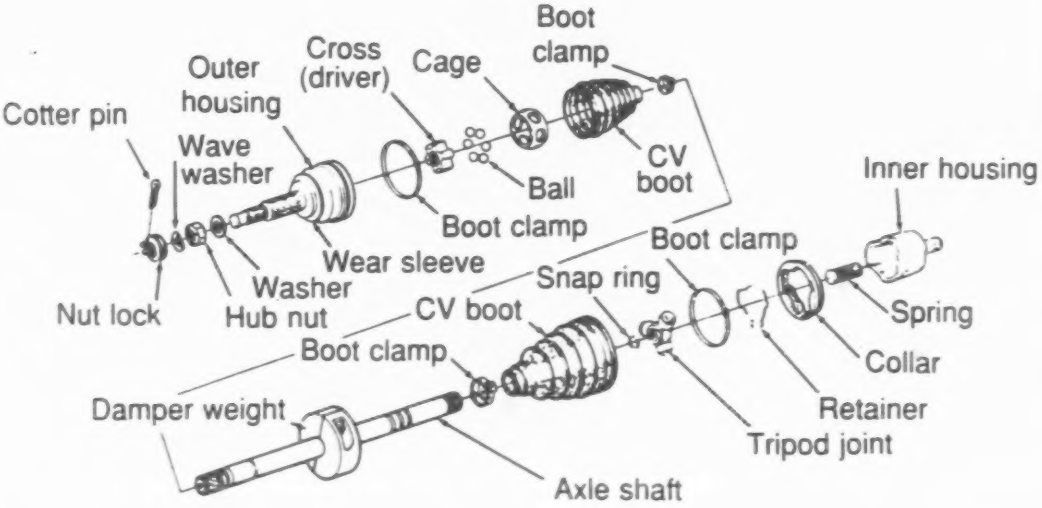
FIGURE 7



Exploded View of Typical Axle Shaft Assembly (Chrysler)

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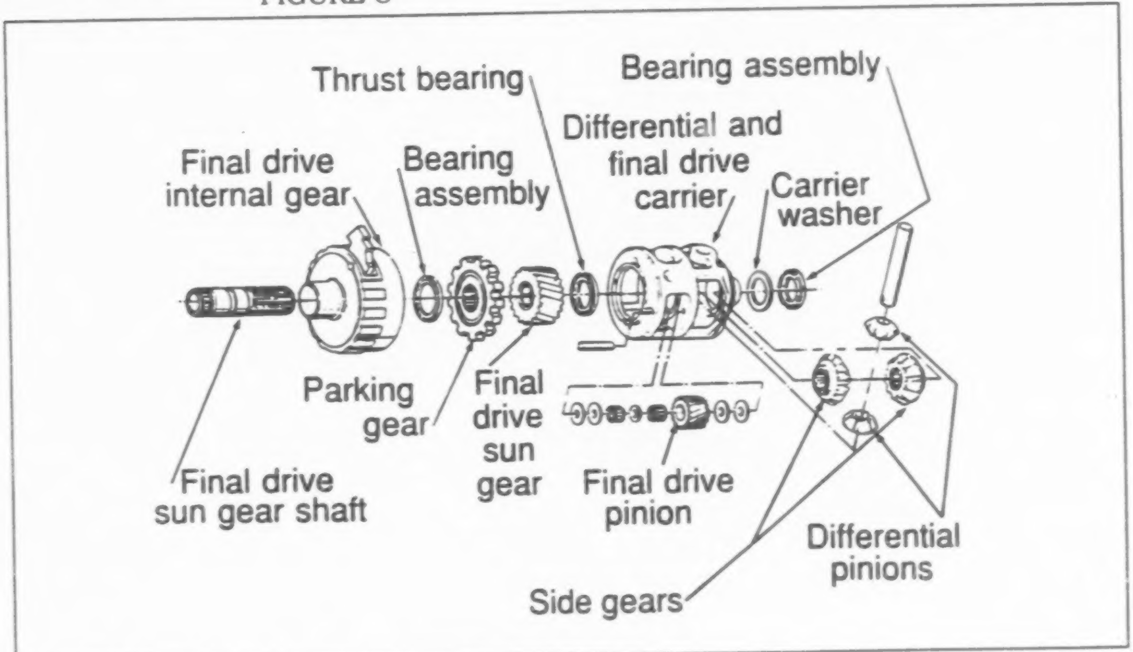
OBJECTIVE 8

Label the parts of a typical final drive and differential assembly.

Optional Activities/
Resources in
Instructor's Guide

Required Activities/
Resources in
Instructor's Guide

FIGURE 8



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OBJECTIVE 9

Optional Activities/ Resources in Instructor's Guide

Required Activities/ Resources in Instructor's Guide

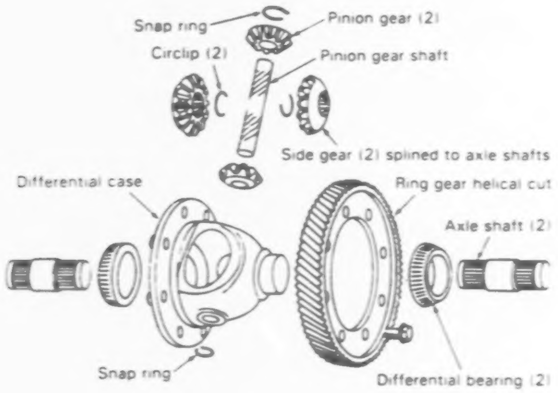
Identify final drive arrangements and gear types.

WORDS YOU SHOULD KNOW

final drive	last gear assembly (reduction) in the power train ☑ **NOTE:** What is encompassed in the definition of final drive varies with the user and with the vehicle or assembly under discussion. Often the definition encompasses the entire assembly of shafts, gears, and even clutches used to transmit power from the transmission/ transaxle to the drive wheels. Strictly speaking, however, final drive is the ring and pinion, or final gearset, excluding the differential gears.
longitudinally-mounted engine	engine mounted at right angle (across) the axle
transverse-mounted engine	engine mounted parallel to axle

- Helical-cut final drive gearset (Figure 9)

FIGURE 9



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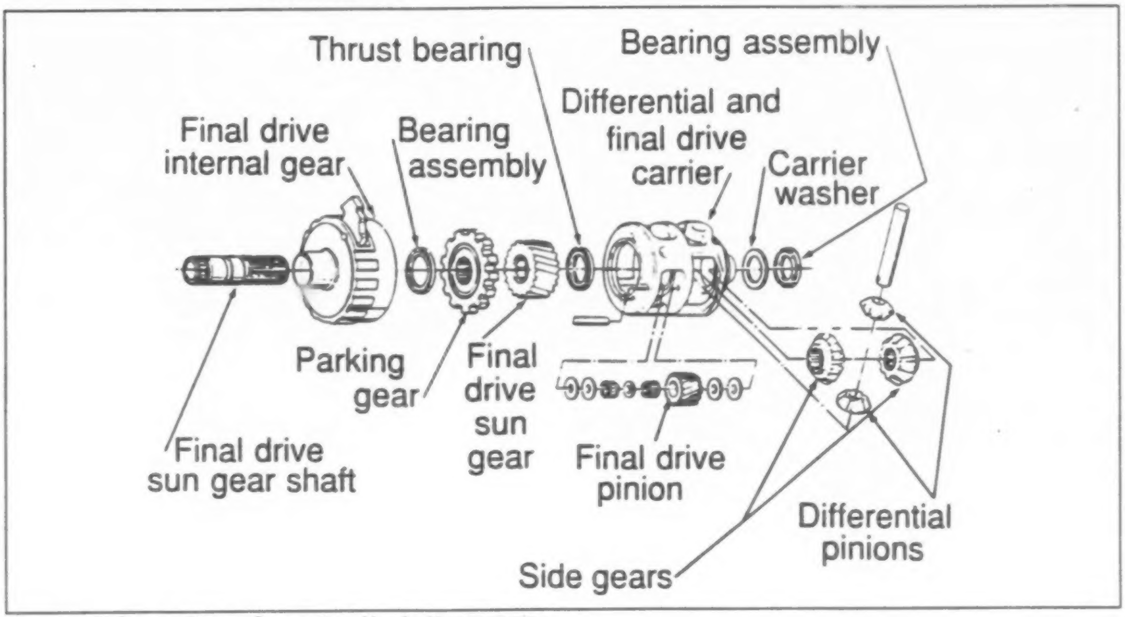
- Final drive planetary gearset and differential assembly (Figure 10)

FIGURE 10



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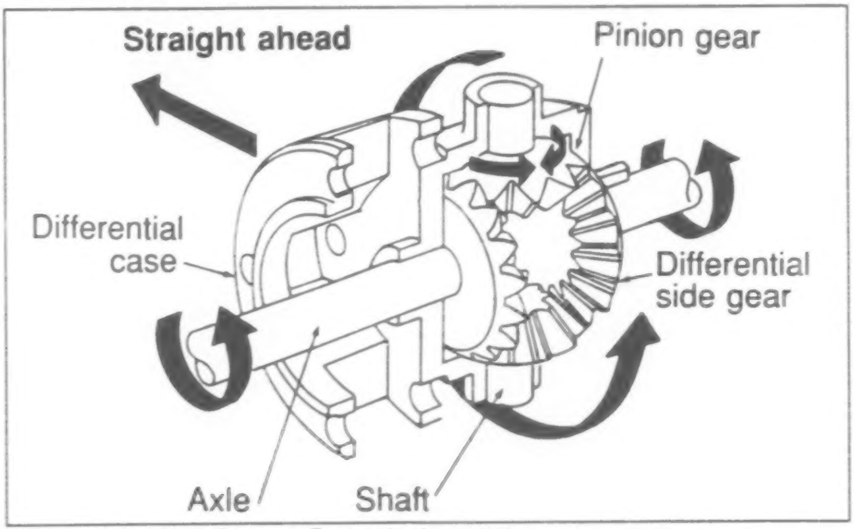
- Bevel gear final drive (Figure 11)

FIGURE 11



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OBJECTIVES 10-15

Complete Job Sheets 1-6.

JOB SHEET 1

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Name ____

OBJECTIVE 10

Replace external seals and gaskets.

INTRODUCTION

Most transaxles have many covers bolted to them and shafts running through them.. Some types of seal is necessary to prevent leakage at each place. The type of seal ranges from a flat gasket to an O-ring to a metal-clad seal. anyone can take one seal off and replace it with another. The dedicated technician will take the time also to see that the new seal fits properly.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Compressed air
- Manufacturer's recommended lubricant
- Manufacturer's recommended transaxle fluid
- Reseal kit containing appropriate replacement seals
- Special seal removers and installers as necessary
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Reading Comprehension Skills
- Gain factual information
- Draw conclusions

Research and Reference Skills
- Locate resources
- Use standard references
- Use in-book reference tools

Remove external gaskets and seals (covers with flat gaskets or O-rings).	Yes	No
1. Raise vehicle on hoist.	____	____
2. Remove all dirt from around mating surfaces.	____	____

CAUTION: If you blow off the dirt with compressed air, wear eye protection to prevent eye injury.

	Yes	No
3. Place drain pan under cover to be removed.	____	____
4. Loosen bolts or clips that hold cover in place.	____	____

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

CAUTION: Some accumulator and servo covers contain a strong spring. Be careful that it does not fly off and hit you.

---

5. Remove cover, gasket, and/or O-ring. ____ ____
6. Place gaskets and O-rings with the component from which they were removed. ____ ____
7. Scrape old gasket material from both mating surfaces, taking care not to scratch the surfaces. ____ ____
8. Clean cover with solvent and blow dry. ____ ____

CAUTION: Wear eye protection to prevent eye injury.

---

9. Check new seal against removed seal for proper type, size, and thickness. ____ ____
10. Check new seal for fit. ____ ____
11. Install new seal, using appropriate seal installer and following manufacturer's instructions. ____ ____
12. Install cover, tightening bolts to manufacturer's torque specifications. ____ ____
13. Lower vehicle, and replace any lost fluid. ____ ____

PROCEDURE

Remove external gaskets and seals (shafts with metal-clad seals).

1. Raise vehicle on hoist. ____ ____
2. Remove all dirt from around seal. ____ ____

CAUTION: If you blow off the dirt with compressed air, wear eye protection to prevent eye injury.

---

3. Place drain pan under seal to be replaced. ____ ____
4. Remove linkage from shaft. ____ ____

Yes No

5. Carefully pry old seal out of housing, taking care not to nick housing surface. ____ ____

6. Place seal with component from which it was removed. ____ ____

7. Clean area where new seal will be installed. ____ ____

8. Check new seal against removed seal for proper type, size, and thickness. ____ ____

9. Check new seal for fit. ____ ____

10. Install new seal, using appropriate seal installer and following manufacturer's instructions. ____ ____

⚠ **CAUTION:** Make sure that you drive against the outer edge of the new seal only. Driving against the inner edge can damage the seal and cause continued leakage.

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11. Install linkage. ____ ____

12. Lower vehicle, and replace any lost fluid. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria: .

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

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JOB SHEET 2

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

Name ______________________________

OBJECTIVE 11 **Remove transaxle.**

INTRODUCTION

There is no single, detailed procedure that the technician can use to remove *all* transaxles. Body style, model year, and the engine/transaxle combination make each job a little different. Describing the exact removal procedures for each particular transaxle is not possible in this job sheet, nor is it necessary. Removing an automatic transaxle is not difficult if the technician uses common sense and good judgement; has at hand the necessary service manual, tools, and equipment; and follows a logical procedure. The technician should be able to adapt the following procedure to work with any automatic transaxle. Refer to your service manual for procedures specific to the vehicle you are servicing.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Large drain pan
- Tilting-base transmission jack suitable for FWD vehicles
- Engine support bracket
- C-clamp
- Safety strap or chain
- Carburetor cleaner or hot-solution parts cleaning tank
- Shop towels
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Reading Comprehension Skills
- Gain factual information
- Draw conclusions

Research and Reference Skills
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
1. Open hood and think through job, trying to visualize what will happen when you lower transaxle for removal.	____	____
☑ **NOTE:** The engine is not lowered in this procedure for front-wheel drive transaxle removal.		
2. Disconnect battery ground cable.	____	____
☑ **NOTE:** Disconnecting the battery ground cable prevents a short circuit if you accidentally ground any wires while removing the starter motor or other electrical parts.		
3. Remove air cleaner.	____	____
4. Disconnect throttle valve linkage.	____	____
5. Disconnect any electrical connections to engine and transaxle that would interfere with transaxle removal.	____	____
6. Remove engine-to-transaxle bolts as specified by manufacturer.	____	____
7. Unbolt and remove starter motor.	____	____
8. Support engine with a bracket, either from cowl to radiator or from protected area across front fenders.	____	____
9. Remove strut brackets that bolt at transaxle, if vehicle is so equipped.	____	____
10. Disconnect speedometer cable.	____	____
11. Disconnect cruise control, if vehicle is so equipped.	____	____

Yes No

12. Leaving the hood open, safely raise vehicle to proper working height on a hoist. ____ ____

☑ **NOTE:** By leaving the hood open, you can prevent damage caused by an engine-mounted part moving enough to strike the hood. An open hood also allows more light to fall on your work.

13. Drain transaxle of fluid. ____ ____

☑ **NOTE:** If necessary, refer to Unit 2 and your shop service manual for this procedure.

14. Remove right and left axle shafts from transaxle, unlocking steering column if necessary. ____ ____

15. If required, remove ball joint cotter pin and retaining nut, and then separate ball joint from control arm. ____ ____

16. If required, remove stabilizer rod and bolted crossmember. ____ ____

17. Remove any wiring still attached to transaxle. ____ ____

18. Remove dust cover from bellhousing. ____ ____

19. Place a large drain pan under transaxle oil pan. ____ ____

20. Remove dipstick and filler tube. ____ ____

21. When draining is complete, use several bolts to replace oil pan, which will provide a surface for the transmission jack. ____ ____

22. Move drain pan under fluid cooler lines. ____ ____

23. Remove transaxle fluid cooler lines.

- Remove any clamps or clips used to hold cooler lines in place. ____ ____

Yes No

- Place drain pan under cooler lines. ____ ____

- Using two wrenches—one to hold fitting and one to loosen tubing nut—carefully disconnect lines. ____ ____

  ☑ **NOTE:** Using two wrenches in this manner prevents damage to the cooler line and fitting.

24. Plug cooler lines to keep out dirt. ____ ____

25. Support transaxle with transmission jack designed for front-wheel drive vehicles. ____ ____

- Place transmission jack squarely under transaxle oil pan. ____ ____

- Adjust height of jack—tilting base plate to fit oil pan—and tighten adjusting screws. ____ ____

- Move each corner of base plate into position, and tighten retaining bolts. ____ ____

  ☑ **NOTE:** When properly adjusted, the transaxle oil pan should fit *into* the jack base plate.

- Secure transaxle to jack with a safety chain or strap. ____ ____

- Raise jack slightly to relieve weight on rear transaxle mount. ____ ____

26. Remove any transaxle-to-frame mounts. ____ ____

27. If possible, mark relationship of torque converter and flexplate or flywheel, so that you can reinstall converter in exact same location to maintain engine and converter balance. ____ ____

☑ **NOTE:** On some front-wheel drive vehicles, you cannot see the converter yet, and this task will have to wait until after the transaxle has been lowered (Step 32).

Yes No

28. Remove nuts or bolts that attach converter to flexplate or flywheel.

- Rotate engine to gain access to all bolts and nuts. ____ ____

- Use a large wrench on crankshaft pulley nut. ____ ____

⚠ **CAUTION:** Do not leave the converter attached to the engine while removing the transaxle. This could damage the input shaft, the converter, and the pump.

---

29. Remove the last bellhousing-to-engine bolt. ____ ____

30. Pry between engine and transaxle to separate them. ____ ____

31. Make one last check to ensure that no components are left to interfere with transaxle removal: all disconnected linkage, lines, and wires should be clear of the transaxle. ____ ____

32. Slowly lower transaxle, taking care not to pry on the case and grasping torque converter to make sure that it moves as a unit with transaxle. ____ ____

☑ **NOTE:** If holding the torque converter with your hand is awkward, attach a small C-clamp to the edge of the bellhousing to hold it in place.

33. If you could not mark the relationship of converter and flexplate or flywheel earlier, do so now. ____ ____

34. Carefully remove converter from front of transaxle, pulling it straight out to prevent scoring front pump or seal. ____ ____

35. Place converter flat on an unused part of workbench. ____ ____

Yes No

36. Remove nuts or bolts that attach converter to flexplate or flywheel. ____ ____

☑ **NOTE:** The flexplate must be replaced if any cracks or out-of-round holes are found.

37. Transfer transaxle to a support stand or place it on a clean workbench if a stand is not available. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

JOB SHEET 3

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Name ______________________________

OBJECTIVE 12 **Disassemble and clean transaxle.**

INTRODUCTION

After the transaxle has been removed from the vehicle, it is a good practice to clean the exterior before disassembly. Steam or high-pressure hot water cleaning is the preferred cleaning method; however, the method you use will depend on the type of cleaner at your facility.

Before you do any exterior cleaning, make sure that you remove the torque converter and dipstick tube. Plug the hole where the tube was to prevent cleaning solution from entering the case. Also remove any external electrical wires or devices that could be damaged by high-pressure or excessive heat.

Disassemble the transaxle in an orderly and sequential manner, arranging all parts in their order of removal, and placing small parts on a clean shop towel in an area where they will not be underfoot or in the way.

Guidelines

- Remove all gaskets, O-rings, seals, and sealing rings before you attempt to clean any part.
- *Do not* throw old gaskets and seals away. Keep them with the component from which they were removed. They will be needed later for comparison with the new gaskets and seals. This is especially true of valve body gaskets.

> ⚠ **CAUTION:** Many overhaul kits come with steel sealing rings to replace the Teflon ones. *Make sure* that you check the steel replacement in the groove carefully. In some cases, the depth of the Teflon ring groove is less than that of one for a steel ring. Even though the steel replacement will fit the bore, if the groove is not deep enough, the ring cannot compress enough when installed. As a result, the steel ring will break as the parts are assembled.

- Clean in carburetor cleaner or in a hot-solution parts cleaning tank all "hard parts" that are coated with varnish.

- Air dry cleaned parts only. Do not use shop towels as they may leave lint that will later clog the filter or valve body.

⚠ **CAUTION:** To prevent eye damage, always wear eye protection when air drying parts.

- Coat all iron or steel parts with clean ATF to prevent rusting.

- Make sure that case and all attaching parts are thoroughly cleaned in either carburetor cleaner or in a hot-solution parts cleaning tank.

- Keep all internal parts in order of removal to prevent problems during reassembly. You cannot always rely on a typical illustration to show exactly the same transaxle that you are working on.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Carburetor cleaner or hot-solution parts cleaning tank
- Shop air
- Shop towels
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Reading Comprehension Skills
- Gain factual information
- Draw conclusions

Research and Reference Skills
- Locate resources
- Use standard references
- Use in-book reference tools

Yes No

☑ **NOTE:** Refer to the appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

1. Consulted appropriate service manual. ____ ____

2. Before cleaning, removed torque converter and dipstick tube and plugged hole where tube was. ____ ____

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
3. Removed any external electrical wires or devices that could be damaged during the cleaning process.	____	____
4. Removed all gaskets, O-rings, seals, and sealing rings before cleaning any part.	____	____
5. Retained old gaskets and seals.	____	____
6. Kept old gaskets and seals with the component from which they were removed.	____	____
7. Read operating instructions for parts cleaning machine.	____	____
8. Used an approved cleaning solution.	____	____
9. Disassembled the transaxle in an orderly and sequential manner, arranging all assemblies and parts in their order of removal.	____	____
10. Disassembled each assembly according to service manual instructions.	____	____
11. Avoided using force when disassembling transaxle parts.	____	____
12. Kept work area clean, and kept all parts—particularly the valve body—clean and free of lint.	____	____
13. Wore appropriate safety equipment and clothing.	____	____
14. Followed all safety procedures.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

JOB SHEET 4

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

Name ______________________________

OBJECTIVE 13

Inspect converter flexplate assembly.

INTRODUCTION

In nearly all vehicle designs, the mechanical connection from engine to transaxle is between the torque converter housing and a flexplate. The flexplate is made of steel alloy and is about 3⁄32 inch thick. It is bolted to the crankshaft near its center and to the torque converter housing around its perimeter. Often the flexplate includes the starter ring gear, although some designs locate the starter ring gear on the torque converter housing.

The bolt patterns around the center and/or perimeter of the flexplate may not be symmetrical. This pattern ensures that the units are always bolted together the same way. Some bolt patterns, however, *may be* symmetrical; therefore, it is good practice to mark the flexplate-to-converter and flexplate-to-crankshaft during disassembly. In addition, special high-shear bolts are used. Bolts of unknown properties should never be used in their place.

Guidelines

- Evidence of engine oil or coolant leakage may require the removal of the flexplate for inspection.
- Clean the flexplate with solvent recommended in service manual.
- Inspect flexplate for metal-fatigue cracks, especially in the areas around the perimeter bolt holes.
- Inspect flexplate bolt holes for out-of-round wear; replace flexplate if bolt holes are worn out of round.
- Replace the flexplate if any cracks or out-of-round holes are found.
- If flexplate has been removed, observe bolt tightening torque values at reassembly—excessive torque can lead to stress fractures.

- Check runout against service manual specifications.

☑ **NOTE:** During transmission installation, follow service manual specifications for converter installation (to make certain that it engages the oil pump) and for distance the converter must be moved forward to meet the flexplate. If this distance is too great, the slots in the converter boss might not completely engage the pump lugs, causing excessive wear or disengagement.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Cleaning solvent
- Shop air/towels
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Reading Comprehension Skills

- Gain factual information
- Draw conclusions

Research and Reference Skills

- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading Skills

- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

☑ **NOTE:** Refer to the appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Consulted appropriate service manual.	____	____
2. Cleaned flexplate before inspecting.	____	____
3. Inspected for metal-fatigue cracks and out-of-round bolt holes; replaced if bolt holes were damaged.	____	____
4. Reassembled and torqued to manufacturer's specifications.	____	____
5. Checked runout against service manual specifications.	____	____
6. Used an approved cleaning solution.	____	____
7. Followed all safety procedures.	____	____

SKILL TEST RECORD

Job Acquisition/Development Skills

- Master specific job task/procedure
- Practice good work habits/attitudes

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

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JOB SHEET 5 — SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Name ______________________________

OBJECTIVE 14 **Inspect transaxle drive link assembly.**

INTRODUCTION

Often when a component of the drive link assembly is damaged or worn, the customer will complain of hearing specific noises as described in the vehicle's service manual. After test driving the vehicle to make sure that the noises are not related to the final drive gear, pump, engine or engine accessories, the automatic transmission specialist should suspect and inspect the transaxle drive link assembly.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Large drain pan
- Tilting-base transmission jack suitable for FWD vehicles
- Engine support bracket
- C-clamp
- Safety strap or chain
- Shop towels
- Drive link replacement parts (sprocket, chain assembly sprocket support roller bearings, drive sprocket support bearing) as required
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Reading Comprehension Skills

- Gain factual information
- Draw conclusions

	Yes	No
1. Remove transaxle. (See Job Sheet 2.)	____	____
2. Remove channel plate, following service manual instructions.	____	____
3. Using manufacturer's specifications, check drive chain for excessive stretch.	____	____

Research and Reference Skills
- Follow written instructions
- Locate resources
- Use standard references
- Use in-book reference tools

Functional Reading Skills
- Interpret graphics and symbols
- Use content area vocabulary

Cognitive Activity Skills
- Transfer knowledge/training to new situations

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
4. Rotate drive link assembly to check whether drive link chain binds on sprockets.	____	____
5. If drive chain binds, inspect all teeth of the drive sprocket (all should be identical).	____	____

☑ **NOTE:** If any teeth are different or damaged, the sprocket must be replaced.

	Yes	No
6. Rotate drive link chain assembly to check the ease with which the assembly turns.	____	____
7. If drive link chain assembly rotates easily without drag or resistance, check it for broken link(s).	____	____

☑ **NOTE:** The drive link chain assembly must be replaced if links are broken or worn.

	Yes	No
8. Check drive and driven sprocket teeth.	____	____

☑ **NOTE:** If any teeth are different or damaged, the suspected parts should be replaced.

	Yes	No
9. Check areas where sprockets ride against bearings or thrust washers.	____	____

☑ **NOTE:** If necessary, replace the sprockets.

	Yes	No
10. Check drive and driven sprocket support roller bearings for damage or missing needle(s).	____	____

☑ **NOTE:** The sprocket support roller bearings should be replaced if damaged or missing needle(s). Plastic thrust washers should also be replaced if necessary.

	Yes	No
11. Check for missing or damaged 4th clutch shaft bearing assembly, if vehicle is so equipped.	____	____

☑ **NOTE:** One needle will be missing to allow oil to lubricate the 4th clutch assembly. If all parts are okay, replace the drive sprocket support bearing.

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY	
	4 Skilled — Can perform job with no additional training.
	3 Moderately Skilled — Has performed job during training program; limited additional training may be required.
	2 Limited Skill — Has performed job during training program; additional training is required to develop skill.
	1 Unskilled — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS ______________________________

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JOB SHEET 6

SERVICING FRONT-WHEEL DRIVE TRANSAXLES

7

Name ____

OBJECTIVE 15

Inspect transaxle final drive components.

INTRODUCTION

After the transaxle has been disassembled for repairs, the technician should inspect the final drive components. Careful inspection and appropriate replacement of worn or damaged parts are essential parts of routine front-wheel drive service.

EQUIPMENT AND SUPPLIES

- Benched transaxle final drive components
- Eye protection
- Basic hand tool set
- Feeler gauge
- Pin punch
- Replacement washers and bushings
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Reading Comprehension Skills
- Gain factual information
- Draw conclusions

Research and Reference Skills
- Locate resources
- Use standard references
- Use in-book reference tools

	Yes	No
1. Inspect internal gear for damaged teeth, worn bearing surfaces, broken parking pawl spring, or damage to parking pawl (if applicable).	____	____
2. Inspect sun gear for wear or damage.	____	____
3. Inspect thrust bearings for wear or damage.	____	____
4. Inspect parking gear and governor drive gear for wear or damage.	____	____
5. Check final drive carrier pinion gears for excessive end play.		
• Measure end play between carrier and pinion gear with feeler gauge.	____	____

Functional Reading Skills
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Job Acquisition/ Development Skills
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
• Compare measurement to service manual specifications.	____	____
6. Drive differential pinion shaft retainer pin from carrier with a pin punch.	____	____
7. Remove pinion shaft, pinion and side gears, and thrust washers.	____	____
8. Inspect all parts for damage or abnormal wear.	____	____
9. Inspect final drive sun gear shaft for damaged splines or journals.	____	____
10. Follow the service manual for type and material of replacement washers.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

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PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1

Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

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OBJECTIVE SHEET

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

INTRODUCTION

Manufacturers have compiled diagnostic aids for technicians to use when analyzing automatic transmission/transaxle malfunctions. Diagnostic symptom charts, operational shift speed charts, oil pressure specifications, clutch and band application charts, and oil flow schematics are some of the aids available. In addition, the technician can simplify the diagnostic process by following a definite procedure and by understanding the basic operation of the specific transmission/transaxle that is being inspected or serviced. However, the technician should never attempt to take shortcuts or to assume that another technician has performed adjustments and critical checks.

Numerous vehicle manufacturers provide a *diagnosis check sheet* to be filled out by the diagnostician. The chart contains checklists pertaining to operation, fluid level, oil pressure (idling and at various speeds), verification of adjustments, and possible causes and needed corrections for malfunctions. It is a good policy to use this check sheet for the evaluation of all transmission/transaxle diagnosis. Also a copy of the completed check sheet should be placed in the owner's service file for future reference.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS

PREREADING:	Read the section in your textbook that deals with diagnosing problems with automatic transmissions/transaxles.
WRITING:	Refer to the color-coded oil pressure circuits in your textbook or in a service manual. Choose a circuit, and write several paragraphs describing the sequence and purpose of that circuit's flow of oil pressure in an automatic transmission/ transaxle.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Assignment Sheets and Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. List the basic steps in automatic transmission diagnosis.
2. Read an oil circuit diagram. (Assignment Sheet 1)
3. Read application/range reference charts. (Assignment Sheet 2)
4. Read troubleshooting charts. (Assignment Sheet 3)
5. Read an electrical circuit test chart. (Assignment Sheet 4)
6. Distinguish among the purposes of pressure tests, stall tests, and lock-up converter system tests.
7. List safety guidelines for performing pressure tests, stall tests, and lock-up converter system tests.
8. Perform a stall test. (Job Sheet 1)
9. Perform a road test. (Job Sheet 2)

10. Perform control pressure tests. (Job Sheet 3)
11. Perform lock-up converter system tests. (Job Sheet 4)

INFORMATION SHEET

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

OBJECTIVE 1

Optional Activities/
Resources in
Instructor's Guide

List the basic steps in automatic transmission diagnosis.

WORDS YOU SHOULD KNOW	
remedy	correction
symptom	condition
troubleshooting chart	list of all possible symptoms that might be detected in faulty transmission operation, followed by list of possible causes, followed by suggested remedy

Step 1: Verify the problem.

- Listen to the customer describe the symptoms.
- Check engine oil and ATF dipsticks, noting the condition of each.
- Conduct a thorough check of mechanical, vacuum, hydraulic, and/or electrical connections that might be involved based on customer's description of symptoms.
- If the vehicle is drivable, have the customer take you for a ride so that you can interpret performance and noises that led to customer's complaint.
- Use appropriate service manual tables and charts to compare the indications you get to expected indications for a normally operating system.

Step 2: Narrow the problem.

- Determine what seems to be the most likely cause of the problem.
- Refer to and follow service manual troubleshooting flow chart, if available and appropriate.

Step 3: Perform tests and inspections.

- Begin with tests that will verify the most probable cause; continue testing, if necessary, with the next probable cause.
- Begin with the simplest tests and inspections and work to more complex as necessary.

Step 4: Repair the indicated problem, following recommended service procedure, including required adjustments.

Step 5: Verify that the original problem has been solved and that no new ones have been created.

- Operate the system under various conditions.
- Perform tests, inspections, and measurements as needed to confirm that the problem has been corrected.

OBJECTIVE 2

Complete Assignment Sheet 1.

OBJECTIVE 3

Complete Assignment Sheet 2.

OBJECTIVE 4

Complete Assignment Sheet 3.

OBJECTIVE 5

Complete Assignment Sheet 4.

OBJECTIVE 6

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

Distinguish among the purposes of stall tests, road tests, control pressure tests, and lock-up converter system tests.

- **stall test**
  - ☐ determining whether the clutches and bands are slipping
  - ☐ checking stator operation in the torque converter
- **road test**
  - ☐ determining correct shift speeds/ranges for the transmission being tested
  - ☐ verifying customer complaint(s)

- **control pressure test**
  - ☐ determining whether oil and/or vacuum pressures in the various transmission circuits are normal
  - ☐ revealing possible problems in the oil pump, governor, and throttle circuits
- **lock-up converter system test**
  - ☐ checking torque converter clutch (TCC) lock-up application
  - ☐ diagnosing electrical problems in the TCC system

OBJECTIVE 7

Required Activities/ Resources in Instructor's Guide

Optional Activities/ Resources in Instructor's Guide

List safety guidelines for performing stall tests, road tests, control pressure tests, and lock-up converter system tests.

- **stall test**
  - ☐ Always check the service manual to determine whether a stall test is recommended.

    ☑ **NOTE:** Some vehicle manufacturers do not recommend a stall test as it could damage motor mounts, clutches, and bands.
  - ☐ To avoid transmission damage, do not hold the throttle open longer than 5 seconds.
  - ☐ Cool down the transmission by allowing a period of 15 to 30 seconds with transmission in neutral and engine speed at 1,000 rpm between each test.
  - ☐ If engine speed exceeds maximum specified limits, immediately release the accelerator, as this is an indication of clutch or band slippage.
  - ☐ Fully apply the service and emergency brakes during this test, and block the drive wheels.

    ☑ **NOTE:** Brake problems may allow the vehicle to move forward, creating a potential hazard or injury situation.
  - ☐ Be sure that the area in front of the vehicle is clear of obstructions, and do not let anyone stand in front of the vehicle when performing this test.

- **road test**
  - ☐ Perform this test with a helper so that you will not be tempted to try to drive and read or record at the same time. Your helper will record shift speeds and refer to the appropriate charts.
  - ☐ Before turning on the engine, spend the necessary time to fasten your seatbelt, adjust mirrors and seat, and familiarize yourself with the vehicle's operating controls.
  - ☐ Conduct road test only on isolated roads with little traffic or on vacant parking lots or specifically-designated test areas.
  - ☐ Drive in a safe manner and only in a manner that is required to check or diagnose proper transmission operation.
  - ☐ Avoid jackrabbit starts, hard cornering, or sudden braking.
  - ☐ Observe all speed limits and obey all traffic laws.
  - ☐ Be extremely careful when backing up; conduct "reverse" tests only on a flat, level road or surface with no dropoffs to the side.
- **control pressure tests**
  - ☐ Never go under a vehicle on a hydraulic jack without first placing jack stands under it.
  - ☐ Enlist a helper to operate the transmission, accelerator, and brake controls inside the vehicle.
  - ☐ Take extreme care if service manual pressure test procedures or equipment require you to be under the vehicle during this test.

    ☑ **NOTE:** The driveline and/or drive wheels will be turning for most tests. Contact with a spinning driveline or wheels can cause *serious physical injury.*
- **lock-up converter system test**— Always refer to appropriate service manual or service bulletin for specific transmission computer tests.

  ☑ **NOTE:** Improper test procedures can damage or destroy computer units.

OBJECTIVE 8	**Complete Job Sheet 1.**
OBJECTIVE 9	**Complete Job Sheet 2.**
OBJECTIVE 10	**Complete Job Sheet 3.**
OBJECTIVE 11	**Complete Job Sheet 4.**

ASSIGNMENT SHEET 1

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Name ______________________________ Score __________

OBJECTIVE 2

Read an oil circuit diagram.

INTRODUCTION

The complex systems in today's automobiles require simple methods of showing how the parts are connected and how they function. Diagrams are used for this purpose. Diagrams are also used to show sequences of events and the flow of energy or substances. Through the use of color, abbreviations, and symbols, diagrams simplify complex relationships. Hydraulic circuit diagrams show how the oil passages inside an automatic transmission are connected to each component. The *oil circuit diagram* is frequently used by the specialist when tracing hard-to-find problems or when doing pressure or air tests. This Assignment Sheet will allow you to practice interpreting automatic transmission oil circuit diagrams.

INSTRUCTIONS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Research and Reference
- Use standard references

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/acronyms

The oil circuit diagram (hydraulic circuit pressure chart) in Figure 1 and Figure 2 shows the positions of the various valves and related components in a FWD park and neutral circuit. The color codes have been deleted from the illustration.

1. Read the description of the circuit on the next page.
2. Use colored markers to color-code the circuit key boxes. Use a different color to indicate each of the following pressures: line, pump suction, throttle, converter, and lubrication.
3. Trace the circuit paths by coloring each to match its color code.
4. Check your answer against an appropriate service manual.

The components of *any* hydraulic control system may generally be grouped in four basic categories:

- The pressure supply system
- The pressure regulation system
- The flow control system, and
- The hydraulic operating units.

Data Analysis and Display

- Interpret charts and tables

Job Acquisition/ Development

- Master specific job task/procedure

The circuit in Figure 1 and Figure 2 shows the pressure supply system and the pressure regulation system, as well as one of the many control valves used in the system. Because there is essentially no difference between park and neutral hydraulic flow, no hydraulic operating units are on at this time.

Line pressure is directed through the manual valve to the throttle valve, pressure regulator valve, and the accumulator. The torque converter is reading filled through the switch valve in both park and neutral. Due to the presence of regulated line pressure in both positions, the oil level can be checked in either position (neutral only on RWD).

See next two pages.

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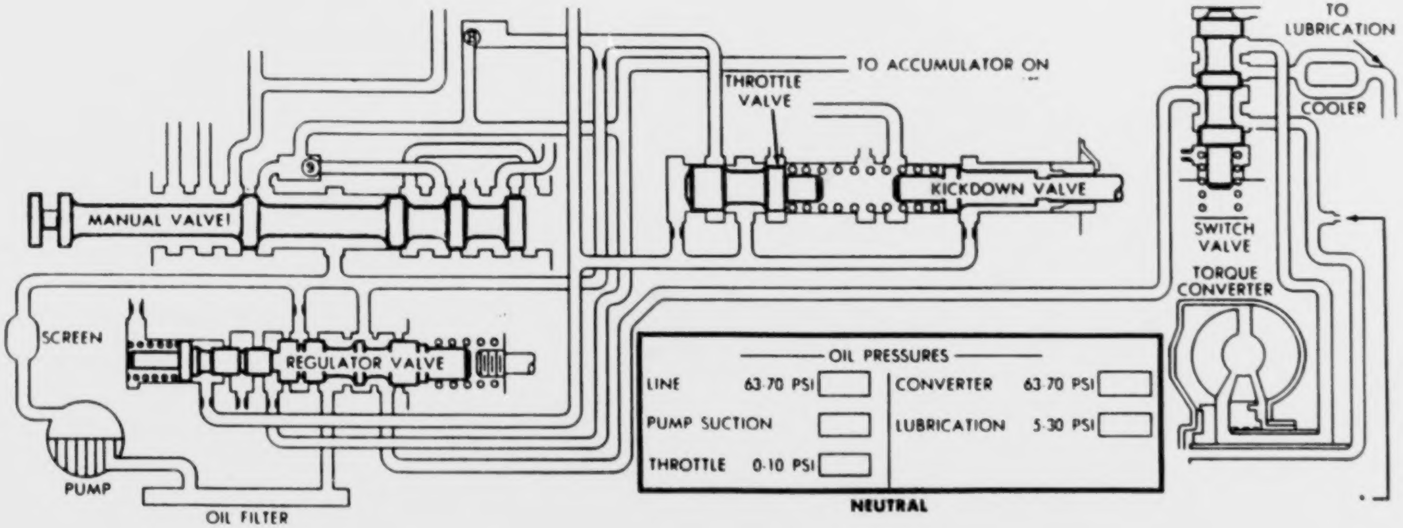
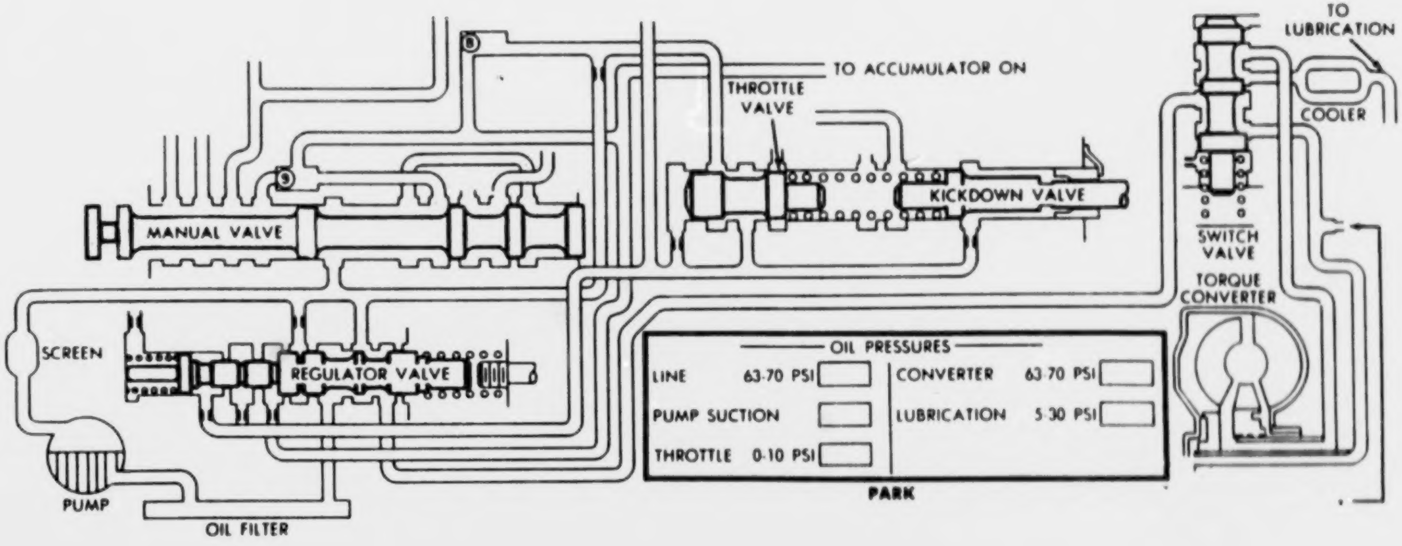


Hydraulic Circuit Pressure — Neutral (FWD)



Hydraulic Circuit Pressure — Park (FWD)

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DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

Name ______________________________ Score __________

OBJECTIVE 3 **Read application/range reference charts.**

INTRODUCTION

Much of the information that the automatic transmission specialist needs is contained in tables (charts). Tables organize information so that it is easy to locate. Tables also often give the same type of information for several different models, vehicle years, automatic transmissions, or other variables.

When checking shift speeds, the specialist is actually evaluating *throttle pressure, governor pressure*, and *valve assembly performance*. Specifications for shift speeds and conditions should be referred to for the model vehicle being serviced. Tire size, final drive ratio, manufacturing tolerances, and variations in throttle position all affect specified shift speeds. Because of this, some manufacturers' tables show more than one column of shift speeds, depending on tire size, while others are not as critical; still others merely suggest what upshifts should occur at one or two specific speeds at approximate throttle openings. Automatic transmission shift speeds are computer-controlled on most of today's vehicles.

Shift speeds are generally noted by the specialist during the road test and then checked against the manufacturer's shift speed specification charts to see whether the shift points occur at the specified speeds. However, because the measurement of governor pressure is required to use a table showing automatic shift speeds and governor pressures, it is referred to when the vehicle is on the rack.

Shift speed tests are difficult to control precisely. The specialist's *observations* of shift quality can be more revealing. Most manufacturers publish clutch and band application charts that assist the automatic transmission specialist in assessing shift quality. These help the specialist pinpoint faulty circuits as well as faulty bands and clutches. Of course, there may be other reasons for substandard shift quality. Some, such as low ATF level and throttle valve adjustment, should have already been checked. Others require the use of a troubleshooting chart (see Assignment Sheet 3).

INSTRUCTIONS

1. Consult the appropriate service manuals to answer the questions that follow. Possible sources may include:
   - *MOTOR Domestic Transmission Manual* (Professional Service/Trade Edition)
   - Mitchell *Transmission Service & Repair: Domestic Cars, Light Trucks & Vans*
   - *Automatic Transmissions and Transaxles: Fundamentals and Systems*, Prentice Hall
   - Manufacturers' service manuals
2. If you cannot locate the appropriate manual(s) to answer a specific question, ask your instructor to provide an alternative question.

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Research and Reference
- Use standard references

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/acronyms

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

Data Analysis and Display
- Interpret charts and tables

Job Acquisition/Development
- Master specific job task/procedure

1. What do the abbreviations CL and CU mean?

2. What is the unit of measurement for the figures under columns 1 through 3 in the shift speed chart for the 1987 Ford Aerostar with a V-6-183 EFI engine?

3. You have test driven a 1987 Aerostar with a tire size of P195/75R14SL and an axle ratio of 3.73. With wide open throttle, it shifted from 2nd to 3rd at 65 mph. Is this an acceptable shift point for this vehicle? If not, what is the acceptable shift speed range?

4. You are checking shift speeds on an Aerostar with a tire size of P205/70R14SL and an axle ratio of 4.10. What is the acceptable 1st to 2nd shift speed range in drive with the throttle closed?

5. What is the acceptable 2nd to 3rd shift speed range in the vehicle in Question 4 when the throttle is wide open?

6. With throttle to detent 2.0 in. Hg vacuum, a 1987 Aerostar with an axle ratio of 3.45 downshifts from 4th to 3rd at approximately 40 mph. Is this an acceptable shift point for this vehicle? If not, what is the acceptable shift speed range?

7. You are checking shift speeds in a 1991 Mark II LSC PKA-EH with a 3.27 axle ratio. At part throttle in overdrive it downshifts from 4th to 3rd at 45 mph and at wide open throttle from 1st to 2nd at 48 mph. Are these acceptable shift points for this vehicle? What are the acceptable shift speed ranges?

8. A 1.8L Colt Vista (transaxle W4A32) with throttle at 70 percent downshifts from 2nd to 1st at approximately 1200 rpm. Is this an acceptable transfer drive gear rpm range for this downshift?

9. What is the minimum acceptable 3rd to 4th shift point (in mph and rpm) for a 1.8L Summit wagon (AWD transaxle W4A32) at about 30 percent throttle?

10. What is the 3rd to 4th shift point (in mph) for a 2.4L Summit wagon at mid-throttle?

11. At what rpm should the 2.4L Colt Vista downshift from 2nd to 1st?

12. Using your scanning tool, you discover that a 1991 Hydra-Matic 4T60 (model 1WHH) with throttle position at 35 percent open shifts from 1st to 2nd at 20 mph. Is this shift point within the acceptable shift range? What is the acceptable range?

13. You are checking shift speeds on another 1991 Hydra-Matic 4T60 (model 1YSH) and find that at 25 percent throttle it shifts from 3rd to 4th at 59 mph. Is this shift point within the acceptable shift range? What is the acceptable range?

____

____

14. You are checking shift speeds and have a 2.6L with an axle ratio of 3.22 on the rack. Governor pressure reads 15 psi. What is the acceptable 1st to 2nd shift speed range?

____

____

15. What is the acceptable 2nd to 3rd upshift speed range for a 2.2L (Turbo) with an axle ratio of 3.02 when governor pressure reads 50 psi?

____

____

16. Second gear is slipping in the Ford AXOD you are servicing. Is it a band or clutch that could be the cause?

____

____

17. A customer with a Ford AXOD finds that she has no reverse gear but the vehicle will move forward. What is the most likely problem?

____

____

18. The Ford AXOD brought in by a customer will not shift into overdrive. What may be the problem?

____

____

19. A Ford AXOD will not move in any gear. What is the most likely problem?

____

____

ASSIGNMENT SHEET 3

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Name ______________________________ Score __________

OBJECTIVE 4

Read troubleshooting charts.

INTRODUCTION

A troubleshooting chart attempts to list all possible symptoms (conditions) that might be detected in faulty transmission/ transaxle operation. Following each symptom is a list of possible causes, usually accompanied by the suggested corrective procedure.

Troubleshooting charts may be specific to a system, such as Troubleshooting Chart 1, designed to allow the specialist to troubleshoot the shift-lock system in Chrysler F3A20 and F4A20 transmission series. Other troubleshooting charts may be general to all transmission components in a particular model/ transmission.

This Assignment Sheet will give you practice in reading troubleshooting charts.

INSTRUCTIONS

Study each of the following troubleshooting charts and answer the questions that follow.

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Research and Reference
- Use standard references

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/ acronyms

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

Data Analysis and Display
- Interpret charts and tables

Job Acquisition/Development
- Master specific job task/procedure

Troubleshooting Chart 1: Chrysler F3A20 & F4A20 Series (Shift-Lock System)

Symptom	Probable Cause	Remedy
The selector lever can be operated from "P"to "R" without depressing the brake pedal when the ignition key is in the ACC position.	• Damaged shift lock lever, foreign matter caught in the mechanism. • Poorly adjusted shift lock cable, broken or disconnected cable. • Broken or fatigued return spring of shift lock cable (shift lock lever side).	• Check selector lever bracket assembly and replace if necessary. • Check, adjust or replace shift lock cable.
The selector lever cannot be moved from "P" to "R" when the brake pedal is depressed with the ignition key in the ACC position.	• Faulty selector lever assembly. • Shift lock cable, key interlock cable, automatic transaxle control cable binding. • Poor routing of shift lock cable, key interlock cable. • Broken or fatigued return spring of shift lock cable (brake pedal side).	• Check selector lever bracket assembly and replace if necessary. • Check, adjust or replace shift lock cable and key interlock cable. • Check routing of cables. • Replace shift lock cable.
The selector lever can be moved from "P" to "R" when the brake pedal is depressed even though the ignition key is in the LOCK position.	• Deformed, damaged or worn interlock cam or interlock lever. • Poorly adjusted, broken, stretched or disconnected key interlock cable.	• Check interlock cam and interlock lever or replace selector lever bracket assembly. • Check, adjust or replace key interlock cable.
The selector lever cannot be moved smoothly from "P" to "R".	• Shift lock lever cannot be moved smoothly due to a large amount of play or friction of the fulcrum pin of the shift lock lever. • Poorly adjusted shift lock cable, considerable elongation of inner cable. • Poorly adjusted key interlock cable. • Broken or fatigued return spring of shift lock cable (brake pedal side). • Interlock cam and interlock lever not sliding smoothly.	• Check and adjust shift lock lever, check and replace selector lever bracket assembly. • Check and adjust or replace shift lock cable and key interlock cable.
The selector lever cannot be moved from "R" to "P".	• Shift lock lever or interlock cam binding.	• Check selector lever bracket assembly, apply grease or replace assembly.
The ignition key cannot be turned to LOCK when the selector lever is in the "P" position.	• Damaged interlock cam or interlock lever or foreign matter caught in the mechanism. • Poorly adjusted key interlock cable, binding inner cable. • Slide lever in key cylinder not sliding smoothly.	• Check selector lever bracket assembly and replace if necessary. • Adjust or replace key interlock cable. • Check slide lever and replace if necessary.
The ignition key can be turned to LOCK even when the selector lever is at any position other than "P".	• Broken spring pin. • Damaged interlock cam. • Damaged interlock cover. • Poorly adjusted or broken key interlock cable, stretched inner cable. • Damaged slide lever.	• Replace spring pin • Check selector lever bracket assembly and replace if necessary. • Check and adjust or replace key interlock cable. • Replace slide lever.
The stop light stays ON.	• Poorly adjusted shift lock cable. • Broken shift lock cable spring.	• Check and adjust or replace shift lock cable.

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Troubleshooting Chart 2: General Motors THM 440-T4 Automatic Transaxle

CHILTON'S THREE "C's" DIAGNOSIS CHART
THM 440-T4 Automatic Transaxle

Condition	Cause	Correction
Oil Leakage	a) Side cover, bottom pan and gaskets, loose bolts	a) Repair or replace cover, gasket and torque bolts
	b) Damaged seal at T.V. cable, fill tube or electrical connector	b) Replace seal as required
	c) Damaged seal assembly on manual shaft	c) Replace seal assembly as required
	d) Leakage at governor cover, servo covers, modulator, parking plunger guide, speedometer driven gear sleeve	d) Replace damaged "O" ring seals as required
	e) Converter or converter seal leaking	e) Replace converter and seal as required
	f) Axle seals leaking	f) Remove axles and replace seals as required
	g) Pressure ports or cooler line fittings leaking	g) Tighten or repair stripped threads
Fluid foaming or blowing out the vent	a) Fluid level high	a) Correct fluid level
	b) Fluid foaming due to contaminates or overheating of fluid	b) Determine cause of contamination or overheating and repair
	c) Drive sprocket support has plugged drain back holes	c) Open drain back holes in sprocket support
	d) Thermo element not closing when hot	d) Replace thermo element
	e) Fluid filter "O" ring damaged	e) Replace fluid filter "O" ring
High or low fluid pressure, verified by pressure gauge	a) Fluid level high or low	a) Correct fluid level as required
	b) Vacuum modulator or hose leaking	b) Repair or replace hose or modulator
	c) Modulator valve, pressure regulator valve, pressure relief valve nicked, scored or damaged. Spring or ball checks missing or damaged	c) Repair or replace necessary components
	d) Oil pump or components damaged, parts missing	d) Repair or replace oil pump assembly
No drive in DRIVE range	a) Fluid level low	a) Correct fluid level
	b) Fluid pressure low	b) Refer to low fluid pressure causes
	c) Manual linkage mis-adjusted or disconnected	c) Repair or adjust manual linkage
	d) Torque converter loose on flex plate or internal converter damage	d) Verify malfunction and repair as required
	e) Oil pump or drive shaft damaged	e) Repair or replace oil pump and/or drive shaft
	f) Number 13 check ball mis-assembled or missing	f) Correct or install number 13 check ball in its proper location
	g) Damaged drive link chain, sprocket or bearings	g) Replace damaged components

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CHILTON'S THREE "C's" DIAGNOSIS CHART
THM 440-T4 Automatic Transaxle

Condition	Cause	Correction
No drive in DRIVE range	h) Burned or missing clutch plates, damaged piston seals or piston, Housing check ball damaged, input shaft seals or feed passages blocked or damaged	h) Repair and/or replace damaged input clutch assembly components
	i) Input sprag and/or input sun gear assembly improperly assembled or sprag damaged	i) Correctly assemble or replace input sprag and input sun gear assembly
	j) Pinions, sun gear or internal gears damaged on input and reaction carrier assemblies	j) Repair or replace carrier assemblies as required
	k) 1-2 band or servo burned or damaged. Band apply pin incorrect in length	k) Repair or replace band and/or servo components as required
	l) 1-2 servo oil pipes leaking fluid	l) Correct oil tubes to prevent leakage
	m) Final drive assembly broken or damaged	m) Repair or replace necessary components of final drive
	n) Parking pawl spring broken	n) Replace parking pawl spring
	o) Output shaft damage, broken or misassembled	o) Repair, replace or re-assemble output shaft
First speed only, no 1-2 shift	a) Governor assembly defective	a) Repair or replace governor
	b) Number 14 check ball missing	b) Install number 14 check ball
	c) 1-2 shift valve sticking or binding	c) Repair or clean valve and bore
	d) Accumulator and/or pipes	d) Repair/renew components
	e) 2nd clutch assembly damaged	e) Repair/renew components
	f) Oil seal rings damaged on driven sprocket support	f) Replace oil seal rings
	g) Splines damaged or parts missing from reverse reaction drum	g) Repair or replace damaged components
Harsh or soft 1-2 shift	a) Fluid pressure	a) Check pressure and correct
	b) Defective accumulator assembly	b) Repair or replace accumulator assembly
	c) Accumulator valve stuck	c) Repair or clean valve and bore
	d) Missing or mislocated number 8 check ball	d) Install or re-locate number 8 check ball
High or low 1-2 shift speed	a) Disconnected or misadjusted T.V. cable	a) Connect and/or adjust T.V. cable
	b) Bent or damaged T.V. link, lever and bracket assembly	b) Repair or replace damaged components
	c) Stuck or binding T.V. valve and plunger	c) Correct binding condition or remove stuck valve and plunger
	d) Incorrect governor pressure	d) Correct governor pressure
No 2-3 upshift, 1st and 2nd speeds only	a) Defective 1-2 servo or components	a) Repair or replace 1-2 servo assembly
	b) Defective number 7 check ball and capsule assembly	b) Check, repair or replace check ball and capsule
	c) Number 11 check ball not seating	c) Check, repair or replace check ball
	d) 2-3 shift valve stuck in control valve assembly	d) Remove stuck 1-2 shift valve and repair

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CHILTON'S THREE "C's" DIAGNOSIS CHART
THM 440-T4 Automatic Transaxle

Condition	Cause	Correction
No 2-3 upshift, 1st and 2nd speeds only	e) Seals damaged or blocked passages on input shaft f) Defective third clutch assembly g) Defective third roller clutch assembly h) Numbers 5,6 and/or accumulator valve stuck	e) Replace seals and open passages f) Overhaul third clutch assembly g) Inspect, repair or replace necessary components h) Repair as required
Harsh or soft 2-3 shift	a) Fluid pressure b) Mislocated number 12 check ball	a) Test and correct fluid pressure b) Correct check ball location
High or low 2-3 shift speed	a) Disconnected or misadjusted T.V. cable b) Bent or damaged T.V. link, lever and bracket assembly c) Stuck or binding T.V. valve and plunger d) Incorrect governor pressure	a) Connect and/or adjust T.V. cable b) Repair or replace damaged components c) Correct binding condition or remove stuck valve and plunger d) Correct governor pressure
No 3-4 shift	a) Incorrect governor pressure b) 3-4 shift valve stuck in control valve assembly c) Defective 4th clutch assembly d) Spline damage to 4th clutch shaft	a) Correct governor pressure b) Free 3-4 shift valve and repair control valve assembly c) Overhaul 4th clutch assembly d) Replace 4th clutch shaft
Harsh or soft 3-4 shift	a) Fluid pressure b) Defective accumulator assembly c) Mislocated number 1 check ball	a) Test and correct fluid pressure b) Repair or replace accumulator assembly c) Correct check ball location
High or low 3-4 shift	a) Disconnected or misadjusted T.V. cable b) Bent or damaged T.V. link, lever and bracket assembly c) Stuck or binding T.V. valve and plunger d) Incorrect governor pressure	a) Connect and/or adjust T.V. cable b) Repair or replace damaged components c) Correct binding condition or remove stuck valve and plunger d) Correct governor pressure
No converter clutch apply (vehicles equipped with E.C.M.)	a) Improper E.C.M. operation b) Electrical system of transaxle malfunctioning c) Converter clutch apply valve stuck d) Number 10 check ball missing e) Converter clutch blow-off check ball not seating or damaged f) Seals damaged on turbine shaft g) Damaged seal on oil pump drive shaft	a) Verify proper E.Ç.M. operation b) Test and correct electrical malfunction c) Free converter clutch apply valve and repair d) Install missing check ball e) Inspect channel plate and check ball. Repair as required f) Replace seals and inspect shaft g) Replace seal on oil pump drive shaft
No converter clutch apply (vehicles not equipped with E.C.M.)	a) Electrical system of transaxle malfunctioning	a) Test and correct electrical malfunction

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CHILTON'S THREE "C's" DIAGNOSIS CHART
THM 440-T4 Automatic Transaxle

Condition	Cause	Correction
No converter clutch apply (vehicles not equipped with E.C.M.)	b) Converter clutch shift and/or apply valves stuck	b) Free converter clutch shift and/or apply valves
	c) Number 10 check ball missing	c) Install missing check ball
	d) Converter clutch blow-off check ball not seated or damaged	d) Inspect channel plate and check ball. Repair as required
	e) Seals damaged on turbine shaft	e) Replace seals and inspect shaft
	f) Damaged oil seal on seal pump drive shaft	f) Replace seal on oil pump drive shaft
Converter clutch does not release	a) Converter clutch apply valve stuck in the apply position	a) Free apply valve for converter clutch and repair as required
Rough converter clutch apply	a) Converter clutch regulator valve stuck	a) Free converter clutch regulator valve and repair as required
	b) Converter clutch accumulator piston or seal damaged	b) Replace seal or piston as required. Check accumulator spring
	c) Seals damaged on turbine shaft	c) Replace seals on turbine shaft
Harsh 4-3 downshift	a) Number 1 check ball missing in control valve assembly	a) Install number 1 check ball in control valve assembly
Harsh 3-2 downshift	a) 1-2 servo control valve stuck	a) Free 1-2 servo control valve
	b) Number 12 check ball missing	b) Install number 12 check ball
	c) 3-2 control valve stuck	c) Free 3-2 control valve
	d) Number 4 check ball missing	d) Install number 4 check ball
	e) 3-2 coast valve stuck	e) Free 3-2 coast valve
	f) Input clutch accumulator piston or seal damaged	f) Replace input clutch accumulator piston and/or seal
Harsh 2-1 downshift	a) Number 8 check ball missing	a) Install number 8 check ball
No reverse	a) Fluid pressure	a) Test and correct fluid pressure
	b) Defective oil pump	b) Test and correct oil pump malfunction
	c) Broken, stripped or defective drive link assembly	c) Repair, replace as required
	d) Reverse band burned or damaged	d) Replace rear band as required
	e) Defective input clutch	e) Repair, replace defective input clutch components
	f) Defective input sprag	f) Replace defective sprag
	g) Piston or seal damaged, pin selection incorrect for rear servo assembly	g) Repair rear servo as required and install correct pin if needed
	h) Defective input and reaction carriers	h) Replace input and reaction carriers as required
No park range	a) Parking pawl, spring or parking gear damaged	a) Repair as required
	b) Manual linkage broken or out of adjustment	b) Repair linkage or adjust as required
Harsh shift from Neutral to Drive or from Neutral to Reverse	a) Number 9 check ball missing	a) Install number 9 check ball
	b) Number 12 check ball missing	b) Install number 12 check ball
	c) Thermal elements not closing when warm	c) Replace thermal elements
No viscous clutch apply (Vehicles with E.C.M.)	a) Improper E.C.M. operation	a) Verify E.C.M. operation and repair as required
	b) Damaged thermister	b) Replace thermister
	c) Damaged temperature switch	c) Replace temperature switch

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1. A customer brings in a Chrysler with an F3A20 transmission and complains that the selector lever cannot be moved smoothly from park to reverse. List three possible causes.

2. What condition in a Chrysler F3A20 transmission may be caused by a poorly adjusted shift-lock cable or a broken shift-lock cable spring?

3. What corrective action should you take if the shift-lock lever or the interlock cam on a Chrysler F3A20 transmission binds?

4. A customer brings you a General Motors vehicle containing a THM 440-T4 automatic transaxle. The customer complains that he had to have the vehicle towed in because it will not drive in the DRIVE range. After considerable detective work, you determine that the input sprag and input sun gear assembly have been damaged. Should you repair them or replace them with appropriate new components?

5. What condition in a THM 440-T4 automatic transaxle might be caused by thermal elements not closing when warm?

6. You find that a THM 440-T4 automatic transaxle shifts into third too early (at an unacceptably low speed). List the possible causes in order of probability.

For questions 7-10, consult the appropriate service manuals. Possible sources may include Mitchell *Transmission Service & Repair: Domestic Cars, Light Trucks & Vans* and the manufacturer's service publications. If you cannot locate the appropriate manual(s) to answer a specific question, ask your instructor to provide an alternative question.

7. You trace the cause of a low oil pressure reading in an AXOD-E transaxle to a damaged EPC solenoid. What corrective action should you take?

8. A customer brings in a Ford with an AXOD-E transaxle and complains that she cannot shift from first to second gear. You determine that the control assembly bolts are the cause of the problem. They are too loose. To what torque specifications should you tighten the bolts?

9. You are checking shift speeds and determine that the 3-4 shift on a customer's Ford with an AXOD-E transaxle feels harsh or soft. List four likely causes.

10. The converter clutch on a Ford AXOD-E does not release. What systems should you check first?

ASSIGNMENT SHEET 4

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

Name ______________________________ Score __________

OBJECTIVE 5

Read an electrical circuit test chart.

INTRODUCTION

Test charts are different from shift tables and troubleshooting charts. They are usually used for electrical circuits and electromechanical devices such as electronically-controlled lock-up torque converters. Because it is not possible to visually check electrical circuit function, these charts present a logical testing procedure in the form of a branching diagram. The procedure generally starts with a set of conditions that can easily be confirmed as normal and operative. It proceeds with instructions to test specific subcircuits in the most logical way. By the process of elimination, it directs the testing to check out each of the subcircuits as well as the interdependence of any subcircuit upon others. It may also show a schematic diagram identifying connectors and switches in the system, and there may be a narrative procedure in addition to the test chart itself.

If everything checks out okay after the specialist completes the test chart sequence, the specialist probably returns to the troubleshooting chart to select another cause and remedy. When making this selection, the specialist tries to consider all of the observations made to this point in detecting and diagnosing the problem in this particular transmission/transaxle.

INSTRUCTIONS

Study the electrical circuit test charts and answer the questions that follow.

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Research and Reference
- Use standard references

Functional Reading

- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/ acronyms

Language

- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition

- Use complete sentences

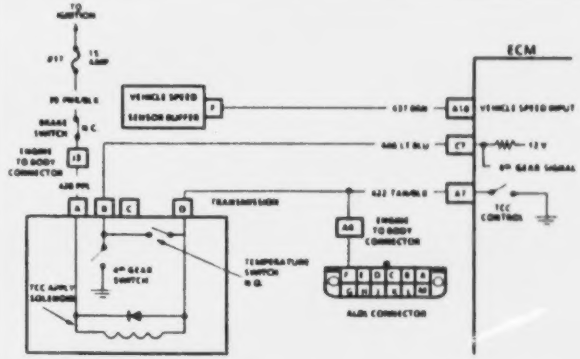
Data Analysis and Display

- Interpret charts and tables

Job Acquisition/ Development

- Master specific job task/procedure

Chart 1: Test Chart C-8A, Torque Converter Clutch Electrical Diagnosis, 4.3L, 5.0L & 5.7L TBI B&D Bodies



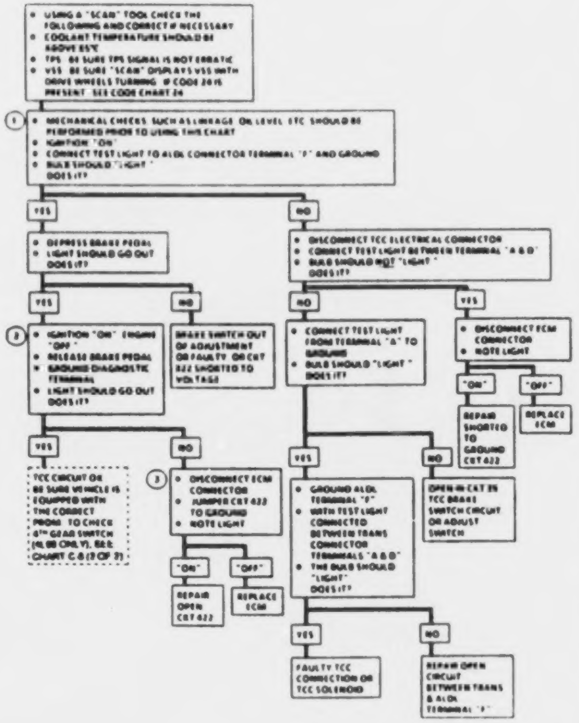
The purpose of automatic transmission torque converter clutch feature is to eliminate power loss of torque converter when vehicle is in cruise condition. This allows convenience of an automatic transmission and fuel economy of a manual transmission. Fused battery ignition is supplied to TCC solenoid through brake switch. The ECM will engage TCC by grounding circuit No. 422 to energize the solenoid. TCC will engage solenoid when vehicle speed is greater than 24 MPH, engine is at normal operating temperature, throttle position sensor output is not changing (indicating a steady road speed), and brake switch is closed.

NOTE: **Test numbers refer to test numbers on diagnostic chart.**

1) Confirms 12-volt supply as well as continuity of TCC circuit.
2) Grounding the diagnostic test terminal with ignition on and engine off should energize the capability of the ECM to control the solenoid.
3) Solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure to the ECM "driver". Using an ohmmeter, check the solenoid coil resistance of all ECM controlled solenoids and relays before installing a replacement ECM. Replace any solenoid or relay that measures less than 20 ohms.

DIAGNOSTIC AIDS

An engine coolant thermostat that is stuck open, or opens at too low a temperature, may result in an inoperative TCC. If TCC engages before "Scan" indicates, solenoid or sump overtemperature switch may be faulty.


USING A "SCAN" TOOL CHECK THE FOLLOWING AND CORRECT IF NECESSARY
COOLANT TEMPERATURE SHOULD BE ABOVE 85°C
TPS - BE SURE TPS SIGNAL IS NOT ERRATIC
VSS - BE SURE "SCAN" DISPLAYS VSS WITH DRIVE WHEELS TURNING. IF CODE 24 IS PRESENT, SEE CODE CHART 24
1
MECHANICAL CHECKS SUCH AS LINKAGE, OIL LEVEL, ETC. SHOULD BE PERFORMED PRIOR TO USING THIS CHART
IGNITION "ON"
CONNECT TEST LIGHT TO ALDL CONNECTOR TERMINAL "F" AND GROUND
BULB SHOULD "LIGHT." DOES IT?
YES
NO
DEPRESS BRAKE PEDAL
LIGHT SHOULD GO OUT. DOES IT?
DISCONNECT TCC ELECTRICAL CONNECTOR
CONNECT TEST LIGHT BETWEEN TERMINAL "A & D"
BULB SHOULD NOT "LIGHT." DOES IT?
YES
NO
NO
YES
2
IGNITION "ON" ENGINE "OFF"
RELEASE BRAKE PEDAL
GROUND DIAGNOSTIC TERMINAL
LIGHT SHOULD GO OUT. DOES IT?
BRAKE SWITCH OUT OF ADJUSTMENT OR FAULTY, OR CKT 422 SHORTED TO VOLTAGE
CONNECT TEST LIGHT FROM TERMINAL "A" TO GROUND
BULB SHOULD "LIGHT." DOES IT?
DISCONNECT ECM CONNECTOR
NOTE LIGHT
"ON"
"OFF"
REPAIR SHORTED TO GROUND CKT 422
REPLACE ECM
YES
NO
YES
NO
TCC CIRCUIT OK. BE SURE VEHICLE IS EQUIPPED WITH THE CORRECT PROM. TO CHECK 4th GEAR SWITCH (4L60 ONLY), SEE CHART C-8 (2 OF 2)
3
DISCONNECT ECM CONNECTOR
JUMPER CKT 422 TO GROUND
NOTE LIGHT
"ON"
"OFF"
REPAIR OPEN CKT 422
REPLACE ECM
GROUND ALDL TERMINAL "F"
WITH TEST LIGHT CONNECTED BETWEEN TRANS CONNECTOR TERMINALS "A & D"
THE BULB SHOULD "LIGHT." DOES IT?
OPEN IN CKT IN TCC BRAKE SWITCH CIRCUIT OR ADJUST SWITCH
YES
NO
FAULTY TCC CONNECTION OR TCC SOLENOID
REPAIR OPEN CIRCUIT BETWEEN TRANS & ALDL TERMINAL "F"

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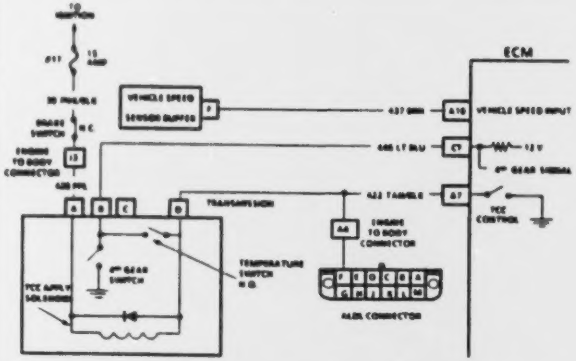


NOTE: **Test numbers refer to test numbers on diagnostic chart.**

1) Unless switch or circuit No. 446 is open, "Scan" tester should display "NO", indicating transmission is not in 4th gear. The 4th gear switch should only be open while in 4th gear.

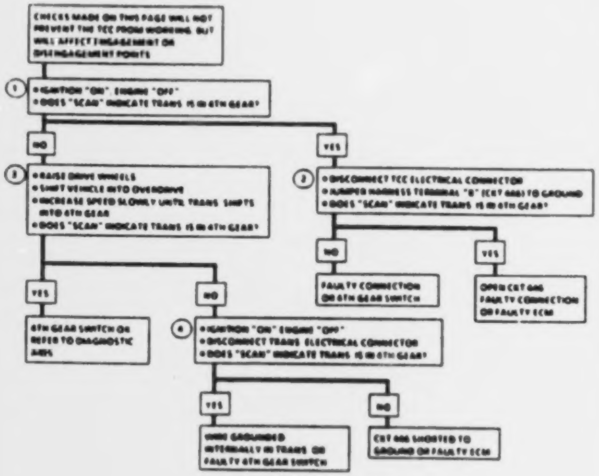
2) This test determines if the ECM and wiring are okay. Grounding circuit No. 446 should cause "Scan" tester to display "NO", indicating the transmission is not in 4th gear.

3) Checks operation of the 4th gear switch. When the transmission shifts into 4th gear the switch should open and "Scan" tester should display "YES".

4) Disconnecting the TCC connector simulates an open switch to determine if circuit No. 446 is shorted to ground or the problem is in the transmission.

DIAGNOSTIC AIDS

A road test may be necessary to verify the customer complaint. If the "Scan" tester indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing state under a steady throttle position. If the switch is changing state, check connections and wire routing carefully. Also if 4th gear switch is always open, the TCC may engage as soon as sufficient oil pressure is reached.


CHECKS MADE ON THIS PAGE WILL NOT PREVENT THE TCC FROM WORKING, BUT WILL AFFECT ENGAGEMENT OR DISENGAGEMENT POINTS
①
• IGNITION "ON", ENGINE "OFF"
• DOES "SCAN" INDICATE TRANS IS IN 4TH GEAR?
NO
YES
③
• RAISE DRIVE WHEELS
• SHIFT VEHICLE INTO OVERDRIVE
• INCREASE SPEED SLOWLY UNTIL TRANS SHIFTS INTO 4TH GEAR
• DOES "SCAN" INDICATE TRANS IS IN 4TH GEAR?
②
• DISCONNECT TCC ELECTRICAL CONNECTOR
• JUMPER HARNESS TERMINAL "B" (CKT 446) TO GROUND
• DOES "SCAN" INDICATE TRANS IS IN 4TH GEAR?
NO
YES
FAULTY CONNECTION OR 4TH GEAR SWITCH
OPEN CKT 446 FAULTY CONNECTION OR FAULTY ECM
YES
NO
4TH GEAR SWITCH OK REFER TO DIAGNOSTIC AIDS
④
• IGNITION "ON" ENGINE "OFF"
• DISCONNECT TRANS ELECTRICAL CONNECTOR
• DOES "SCAN" INDICATE TRANS IS IN 4TH GEAR?
YES
NO
WIRE GROUNDED INTERNALLY IN TRANS OR FAULTY 4TH GEAR SWITCH
CKT 446 SHORTED TO GROUND OR FAULTY ECM

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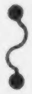
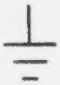
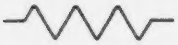
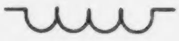
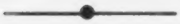
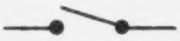
1. What do the following symbols and abbreviations in the electrical diagram mean?
    - 
    - 
    - N.O.
    - 
    - 
    - 
    - 

2. What colors are the electrical wires for the following circuits:
    - circuit 437 ______________________________
    - circuit 446 ______________________________
    - circuit 422 ______________________________
    - circuit 420 ______________________________
    - circuit 39 ______________________________

3. What amperage fuse is used in circuit 39? ______________

4. By what method does the computer (ECM) engage the torque converter clutch?

5. What four conditions must be present for the torque converter clutch to engage the solenoid?

6. The torque converter clutch engages before your scan tool indicates. What may be the problem?

7. What is the purpose of the test numbered 1 on the diagnostic chart, part 1?

8. During your first test procedure, your test light bulb does not light. You take corrective procedures, yet it still does not light. Following the chart, you take additional corrective procedures by connecting the test light from terminal "A" to ground, but the bulb still does not light. What corrective procedures should you take at this point?

9. When you make your first test, the test light bulb goes on, but when you depress the brake pedal, it does not go out as it should. What are the probable causes?

10. What must solenoid coil resistance measure? Why?

____

____

11. What is the primary purpose of Test Chart C-8A, part 2?

____

____

12. What is the purpose of the test numbered 4 on the diagnostic chart, part 2?

____

____

JOB SHEET 1

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Name ______________________________

OBJECTIVE 8

Perform a stall test.

INTRODUCTION

The stall test is required by many manufacturers to determine engine speed at full throttle in the drive (D) position. The driving wheels are locked so that the load is placed on the engine and transmission/transaxle. Results of this test reveal how the stator overrunning clutch and the clutches and bands inside the transmission are operating.

EQUIPMENT AND SUPPLIES

- Wheel blocks
- Tachometer
- Droplight
- Eye protection
- Grease pencil
- Appropriate service manual

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/ acronyms

Yes No

⚠ **CAUTION:** A stall test can ruin weak clutches and bands inside the transmission. Refer to appropriate service manual for make and model as equipped to determine whether stall testing is recommended. If there is any doubt about the condition of the clutches and bands, do *not* perform the stall test.

⚠ **WARNING:** The vehicle can move forward during this test. Be sure that the test area in front of the vehicle is clear. Do *not* let anyone stand in front of the vehicle when performing this test.

---

1. Connect tachometer to engine according to manufacturer's instructions. ____ ____

2. Place tachometer inside vehicle where it can be easily read. ____ ____

Functional Math
- Make measurements

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

3. Mark tachometer dial with a grease pencil at the manufacturer's recommended maximum revolutions per minute (rpm) for this test; record (below) the maximum rpm for test vehicle. ____ ____

Maximum recommended rpm = ____________

⚠ **CAUTION:** Do not exceed maximum rpm at any time during this test. Severe engine or transmission damage could result.

---

4. Check coolant and transmission fluid levels to ensure that they are adequate; fill as necessary. ____ ____
5. Block drive wheels. ____ ____
6. Set emergency brake. ____ ____
7. Place transmission in P or N and warm engine and transmission to operating temperatures. ____ ____
8. Place the gearshift lever into the gear recommended for this test by the vehicle manufacturer. ____ ____
9. Press the accelerator pedal to the floor, pressing down slowly at first to make sure that the vehicle does not move. ____ ____
10. Ease off accelerator pedal when tachometer stops rising; record (below) the highest rpm reading during test. ____ ____

Highest rpm = ____________________

Yes No

⚠ **CAUTION:** If the tachometer needle rises above the recommended rpm, *immediately* remove your foot from the accelerator pedal. Never hold the accelerator pedal down for more than 5 seconds when conducting a stall test. If the rpm rises above the recommended rpm, serious transmission damage can result.

---

11. If another stall test is needed, place the gearshift lever in N and run the engine at about 1,000 rpm for 20 or 30 seconds to cool down the transmission. ____ ____

12. Compare the rpm readings from the stall test to speed charts in the appropriate service manual.

- **Stall speed above recommendation** — If stall speed exceeds manufacturer's recommendation by more than 200 rpm, transmission clutch slippage is indicated. ____ ____

- **Stall speed below recommendation** — If stall speeds are 250 to 300 rpm below the manufacturer's recommendation, the stator overrunning clutch may be defective. Below- recommendation stall speeds may also indicate engine power loss, a problem that can be corrected with an engine tune-up. ____ ____

- **Stall speed within recommendation** — It is always wise to follow up the stall speed test with a road test to double check transmission operation. See Job Sheet 2. ____ ____

- **Stall speed noise** — A whining or siren-like noise in D or R is normal in some transmissions during stall testing. It is caused by fluid flow. However, a loud metallic noise usually indicates a bad torque converter. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS ____

____

____

JOB
SHEET 2

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

8

Name ______________________________

OBJECTIVE 9

Perform a road test.

INTRODUCTION

To find out what symptoms and problems are present, the specialist must know correct shift speeds for the transmission being tested. This may be done by observing and recording shift points during a road test and then comparing those shift speeds with appropriate service manual shift speed charts. The service manual contains shift speed charts that list correct shift speeds for vehicles with various engine, transmission, differential, and tire combinations. See Assignment Sheet 2 for examples of shift speed charts.

EQUIPMENT AND SUPPLIES

- Shift speed chart
- Apply device chart
- Vehicle with automatic transmission
- Paper and pencil
- Helper

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/acronyms

Yes No

⚠ **WARNING:** Perform this test with a helper so that you will not be tempted to try to drive and read or record at the same time. Your helper will record shift speeds and refer to the appropriate charts. Drive in a safe manner and under normal driving conditions. Observe all speed limits and obey traffic laws. Conduct your test only on an isolated road with little traffic.

1. Ask your instructor's permission to conduct a road test. ____ ____

2. Check the transmission fluid level and condition; fill or change if necessary. ____ ____

Functional Math
- Make measurements

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

Yes No

3. Before turning on the engine, spend the necessary time to fasten your seatbelt, adjust mirrors and seat, and familiarize yourself with the vehicle's operating controls. ____ ____

4. Check the drive (D) range.

- Have helper record road speeds and rpm (if vehicle is equipped with a tachometer) at which the transmission shifts from 1st to 2nd and from 2nd to 3rd. ____ ____

Light throttle	Medium throttle	Heavy throttle
1-2 = ____mph	1-2 = ____mph	1-2 = ____mph
1-2 = ____rpm	1-2 = ____rpm	1-2 = ____rpm
2-3 = ____mph	2-3 = ____mph	2-3 = ____mph
2-3 = ____rpm	2-3 = ____rpm	2-3 = ____rpm

- Press accelerator to produce a 3-2 downshift; have helper record speed and rpm ranges. ____ ____

3-2 = ______________________mph

3-2 = ______________________rpm

- Accelerate gently to 45 mph. ____ ____

- Decelerate until transmission produces a 3-1 downshift; have helper record speed and rpm ranges. ____ ____

☑ **NOTE:** Notice how the transmission downshifts from high directly to first.

3-1 = ______________________mph

3-1 = ______________________rpm

Yes No

- Have helper note any problems encountered in drive range. ____ ____

  Problems with D = ____________________

  ____

  ____

5. Check the second or intermediate range.

- Have helper record road speeds and rpm (if vehicle is equipped with a tachometer) at which the transmission upshifts from 1st to 2nd. ____ ____

  1-2 = ____________________mph

  1-2 = ____________________rpm

  ☑ **NOTE:** Some Ford vehicles will start and remain in 2nd gear.

- Check whether transmission shifts past 2nd. ____ ____
- Check for engine braking when the accelerator is released. ____ ____
- Move the gearshift lever back to drive (D). ____ ____
- Accelerate to 30 mph. ____ ____
- Move the gear selector lever back to 2. ____ ____
- Slow down. ____ ____
- Note and have helper record road speeds and rpm at which transmission downshifts to 1st. ____ ____

  2-1 = ____________________mph

  2-1 = ____________________rpm

Yes No

- Bring vehicle to a stop. ____ ____

  ☑ **NOTE:** Ford vehicles will remain in second or intermediate when coasting and stopping.

- Have helper note any problems encountered in intermediate range. ____ ____

  Problems with 2 or intermediate = ______

  ____

  ____

6. Check the low or first (L or 1) range.

- Accelerate from a stop. ____ ____
- Check whether transmission upshifts to 2nd or intermediate range at moderate speeds. ____ ____

  ☑ **NOTE:** Some transmissions will not upshift past low or first gear. Others will upshift to second or intermediate.

- Move gearshift lever into drive (D). ____ ____
- Accelerate to 35 mph. ____ ____
- Move gearshift lever back to low or first (L or 1). ____ ____
- Note whether transmission downshifts all the way to low or first. ____ ____

  ☑ **NOTE:** Some transmissions will downshift to second or intermediate when the gearshift lever is moved to low or first. Then, as the vehicle slows down, the transmission will downshift again to low or first.

Yes No

- Have helper note any transmission problems noted in low or first range. ____ ____

  Problems with L or 1 = ____________________

  ____

  ____

7. Check reverse gear.

- Drive to a vacant parking lot or to a straight, level surface out of traffic. ____ ____
- Stop the vehicle and place the gearshift lever in reverse (R). ____ ____
- Press the accelerator gently; check transmission operation. ____ ____
- Briefly press the accelerator to the floor; check transmission operation. ____ ____

⚠ **WARNING:** Steer carefully to avoid an accident.

- Have helper note any transmission problems noted in reverse. ____ ____

  Problems with R = ____________________

  ____

  ____

8. Return to shop. ____ ____
9. Compare recorded road speeds with manufacturer's shift speed charts. ____ ____
10. Use manufacturer's apply device charts to determine the cause(s) of noted problems. ____ ____
11. Make a note of your diagnosis of the vehicle's transmission problems. ____ ____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
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Product includes proper components/ materials for vehicle make and model.	4	3	2	1
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AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY	4 **Skilled** — Can perform job with no additional training. 3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required. 2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill. 1 **Unskilled** — Is familiar with process, but is unable to perform job.
EVALUATOR'S COMMENTS	____ ____ ____

JOB SHEET 3

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

Name ______________________________

OBJECTIVE 10 **Perform control pressure tests.**

INTRODUCTION

Because procedures for control pressure testing vary greatly among manufacturers, use the guidelines below only as a general guide to pressure testing. When conducting control pressure tests on different transmissions, all or only some of the guideline steps may be necessary. Further, some service manuals may replace some steps with alternate, or different, steps, or additional steps may be required. Also, some manufacturer's procedures call for reading more than one pressure gauge, in addition to a vacuum gauge. Therefore, to perform a control pressure test correctly, always refer to the proper service manual.

Guidelines

- Start the engine and warm it to normal operating temperature; then shut it off.
- Connect a tachometer to the engine, following service manual instructions and making sure that all gauges and instruments are properly connected before restarting the engine.
- Work with a helper inside the vehicle to start the engine and operate the transmission, accelerator, and brake controls.
- Safely raise the vehicle on a hoist to a comfortable working height.
- Connect pressure gauges to specified test ports.
- Use a T-fitting and vacuum tubing, if applicable, to connect vacuum gauge with a shutoff or bleed-down valve to the vacuum modulator line.

⚠ **WARNING:** If service manual procedures require you to be under the vehicle while the test is performed, be extremely careful. The driveline and/or drive wheels will be turning for most tests. Contact with the spinning driveline or wheels can cause serious injury.

- Instruct your helper to restart the engine, and to move the gear selector to the first test position.
- Instruct your helper to run the engine at the specified rpm.
- Note and write down readings on gauges.
- Instruct helper to move transmission controls as specified.
- Note and write down the pressures or changes in pressures.
- Instruct helper to slow the engine and press gently on the service brakes to stop the spinning wheels and driveline.
- Instruct helper to shut off engine.
- Attach pressure and/or vacuum gauges to the proper pressure ports for the next test.
- Repeat the steps above for each test procedure, making notes of all pressures and pressure changes for each test.
- Interpret pressure test readings by referring to service manual pressure test specification charts. Most of these charts list causes for nonspecified pressure readings, but you may have to refer to a separate pressure test troubleshooting chart.

EQUIPMENT AND SUPPLIES

- Vehicle with automatic transmission
- Appropriate service manual
- Manufacturer's pressure test charts
- Manufacturer's pressure test troubleshooting charts
- Tachometer
- Pressure gauges
- Vacuum gauge (if required)
- T-fitting and vacuum tubing (if required)
- Hoist
- Eye protection
- Droplight

PROCEDURE

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/acronyms

Functional Math
- Make measurements

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:	Yes	No
1. Referred to appropriate service manual.		
2. Brought engine to normal operating temperature before beginning test.		
3. Properly connected tachometer to engine.		
4. Worked with a helper inside the vehicle.		
5. Safely raised the vehicle on a hoist.		
6. Connected pressure gauges to specified test ports.		
7. Used a T-fitting and vacuum tubing, if applicable, to connect vacuum gauge to vacuum modulator line.		
8. Used a vacuum gauge with a shutoff or bleed-down valve.		
9. Noted and wrote down all pressures or changes in pressures for each test.		
10. Interpreted pressure test readings by referring to service manual pressure test specification charts.		
11. Followed all safety procedures.		

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

____

____

____

JOB
SHEET 4

DIAGNOSING GENERAL AUTOMATIC TRANSMISSION/TRANSAXLE PROBLEMS

Name ______________________________

OBJECTIVE 11 **Perform lock-up converter system tests.**

INTRODUCTION

Lock-up torque converters were the first transmission components to be electrically- and electronically-controlled. All electrically and electronically controlled torque converter clutches are locked and unlocked using a TCC solenoid. General Motors introduced the first electrical converter clutch controls which used various mechanical and vacuum switches to operate the TCC solenoid. All late model converter clutch systems have electronic controls.Today, the specialist must know how to perform electrical and electronic as well as mechanical tests. However, because the type of TCC control devices vary greatly between gasoline- and diesel-equipped vehicles and among vehicle models, the specialist must consult the appropriate service manual for specific lock-up converter system testing instructions.

In general, a torque converter clutch should not lock until the engine is warm enough to handle the extra load, the vehicle speed is high enough to allow smooth power transmission, and the engine and vehicle speeds are matched so that lock-up will not create a surge or shudder. A torque converter clutch should unlock during braking, during downshifts, whenever torque multiplication is needed in the converter, and when the vehicle comes to a stop.

Guidelines

- Start engine and warm to normal operating temperature.
- Raise vehicle on hoist, observing all safety precautions.
- Use required hand-held computer tester (scanning tool) to make specified tests for input and output signals.
- Have helper operate vehicle on hoist during test.

☑ **NOTE:** The actual road test may be performed with the scanner connected. Take a helper to record readings.

- Remain clear of rotating drive wheels and shafts.
- If input signals are correct but output signals are incorrect, the computer unit must be replaced.
- Follow transmission-specific electrical test procedures outlined in test charts and electrical troubleshooting diagrams.
- Know how to use the recommended transmission-specific scanning tool to interpret test results.
- Test solenoid valves by removing the electrical connector and checking the resistance between the connector and ground, or apply current to the disconnected solenoid valve with a small jumper wire.

EQUIPMENT AND SUPPLIES

- Analog voltmeter
- Ohmmeter
- 12-volt test light
- Jumper wire
- Transmission-specific electronic diagnostic tester
- Appropriate service manual containing electrical test procedures, charts, and circuit diagrams

PROCEDURE

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:	Yes	No
1. Referred to appropriate service manual.	____	____
2. Followed transmission-specific electrical test procedures outlined in test charts and electrical troubleshooting diagrams.	____	____
3. Used transmission-specific scanning tool properly to interpret test results.	____	____
4. Followed all safety procedures.	____	____

Research and Reference
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary
- Interpret abbreviations/ acronyms

Functional Math
- Make measurements

SKILL TEST RECORD

Cognitive Activities
- Analyze/synthesize information
- Draw conclusions

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/ materials for vehicle make and model.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

OBJECTIVE SHEET

TESTING RELATED ELECTRONIC COMPONENTS

9

INTRODUCTION

Today, electronic control systems have replaced many of the mechanical and hydraulic systems used in conventional automatic transmissions. The computer control systems found in today's vehicles consist of complicated networks of electronic components. Where transmissions were once controlled by governors, throttle valves, and vacuum modulators, they are now controlled by throttle position sensors (TPS), coolant temperature sensors (CTS), vehicle speed sensors (VSS), turbine speed sensors (TSS), output shaft speed sensors (OSS), manual lever position sensors (MLPS), and solenoids, to name just a few. This, of course, adds to the knowledge required to completely understand how an automatic transmission works.

The transmission specialist cannot service vehicles equipped with these systems based on mechanical aptitude alone. The most important tool for troubleshooting and servicing transmission/transaxle computer control systems is a thorough understanding of how these systems operate. Because computer control systems vary significantly among manufacturers, the specialist should always consult the appropriate service manual before attempting to service a computer system.

PREREQUISITE

Introduction to Automotive Service

FOCUS ASSIGNMENTS

Reading Comprehension
- Gain factual information
- Analyze cause and effect
- Draw conclusions

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

Composition
- Use complete sentences

FOCUS ASSIGNMENTS	
PREREADING:	Read the material in your textbook about automatic transmission/transaxle computer control systems.
WRITING:	In a well-developed paragraph, summarize the types of related electronic components and their functions.

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Assignment Sheet and Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Match computer control system components with their functions.
2. Describe basic operational stages of a computer control system.
3. Describe the functions of various electrical/electronic test tools.
4. State Ohm's Law.
5. Draw Ohm's Law in wheel expression.
6. List uses of Ohm's Law.
7. State the unit of measure formulas from Ohm's Law.
8. State Ohm's Law for power.
9. Draw Ohm's Law for power in wheel expression.
10. List uses of Ohm's Law for power.

11. State the unit of measure formulas from Ohm's Law for power.

12. Describe the purposes of sensors and switches used to send the electronic control unit information for torque converter clutch operation.

13. List advantages of computer control of torque converter.

14. Explain how a solenoid operates a torque converter clutch.

15. Solve problems involving Ohm's Law. (Assignment Sheet 1)

16. Check circuit continuity with an analog ohmmeter. (Job Sheet 1)

17. Measure current, voltage, and resistance with a digital multimeter (DVOM). (Job Sheet 2)

18. Test transmission/transaxle-related electrical/electronic components. (Job Sheet 3)

19. Perform computer relearn procedures. (Job Sheet 4)

INFORMATION SHEET

TESTING RELATED ELECTRONIC COMPONENTS

9

OBJECTIVE 1

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Match computer control system components with their functions.

- **actuator** — converts electrical output signals into physical (mechanical) action

  ☑ **NOTE:** In an electronic system, the actuator is a solenoid.

- **ALDL** — assembly line diagnostic link
- **CTS** — coolant temperature sensor
- **diagnostic code display** — trouble code flashed by the "check engine" light

  ☑ **NOTE:** The specialist interprets the display by checking the ECU troubleshooting code to establish the circuits affected (many trouble codes are stored in the ECU)

- **diagnostic link (electrical connector)** — checks the computer control system at the factory and provides connecting points (multi-pin terminals) for test equipment in the field
- **electronic control unit (ECU)** — main computer that processes input signals and supplies output data; group of electronic components wired into a unified circuit to produce specific electrical signals in response to external sensor outputs; the "brain" of a vehicle computer system

  ☑ **NOTE:** Each manufacturer calls its computer by a slightly different name. For example, GM calls its computer an Electronic Control Module (ECM). Ford uses the term Electronic Control Assembly (ECA).

- **engine control module (ECM)** — controls the torque converter clutch (TCC)
- **electronic scanner** — device—similar in appearance to a calculator—that, when plugged into the ALDL, allows the specialist to diagnose and test for problems in the ECU

- **memory** — stores data until it is needed for processing operations

  ☑ **NOTE:** The types of memory used in vehicle computer systems include ROM (read only memory), RAM (random access memory), and PROM (programmable read only memory).

- **self-diagnostic system** — detects an abnormal operating condition and places a warning signal (trouble code) into the unit's memory system

- **sensor** — converts physical symptoms to electrical input signals; used to detect a change in a vehicle system and to emit a suitable signal to the ECU

  EXAMPLES: *Throttle position sensor (TPS)* monitors the position of the throttle valve; *vehicle speed sensor (VSS)* responds to vehicle speed to select shift points; *coolant temperature sensor* uses engine operating temperature to adjust shift points and determine when the TCC can be engaged

- **shift program** — set of instructions used by the computer in an electronic shift control system to decide whether to upshift or downshift

- **solenoid** — electronically-controlled, electrically operated output device used to operate some units (execute a mechanical action)

  EXAMPLES: In the Chrysler A-604 transmission, four electric solenoids control transaxle hydraulic circuits. In the Asian Warner 4 transmission, two valve-body solenoids control transmission shifts, while the third is used for torque converter lock-up.

- **switch** — mechanically or hydraulically operated input device that delivers component data to the computer

  EXAMPLES: Examples include neutral safety switch, brake switch, and hydraulic pressure switches in solenoid assemblies. Some models—such as the Asian Warner 4 transmission used in some 1991 Jeep vehicles—mount an electronically-controlled automatic transmission mode selection switch on the instrument panel. The switch allows the driver to select different modes to change transmission upshift characteristics.

- **transmission/transaxle control unit (TCU)** — controls the operation of the shift solenoids and the TCC control solenoid by switching them on and off at the correct time; often works with ECU to also control fuel metering and ignition timing and other functions depending on transmission/transaxle model

  ☑ **NOTE:** Each manufacturer refers to its transmission/transaxle computer in different terms. For instance, Chrysler refers to its A604/41TE transaxle computer as an Electronic Automatic Transaxle (AXE) controller and to its transaxle electronic control system as a Transaxle or Transmission Control Unit (TCU). On the other hand, Geo calls its JF403 transaxle electronic control system an Automatic Transaxle Control Module (ATCM). Gasoline- powered vehicles with Hydra-Matic and THM transmissions use a Powertrain Control Module (PCM) computer, while those with diesel engines use a Transmission Control Module (TCM) computer.

- **trouble code** — activates warning display

  ☑ **NOTE:** Trouble codes are displayed and read/retrieved in several ways. Refer to the service manual for information on how to read trouble codes for the transmission you are servicing.

- **vehicle-speed sensor (VSS)** — produces an electrical signal sent to the ECU/ECM to indicate vehicle speed

OBJECTIVE 2

Optional Activities/
Resources in
Instructor's Guide

Describe basic operational stages of a computer control system.

☑ **NOTE:** Computer control system operation occurs in specific stages that are repeated constantly during system operation.

Stage 1: input — sensors monitor various operating conditions and send electrical signals (representing these conditions) to the ECU.

Stage 2: processing — computer analyzes the input signals from the sensors and uses this information to decide if adjustment needs to be made in monitored system; also decides how the adjustment will be made.

Stage 3: output — decisions made during processing stage are sent out as electrical signals—representing these decisions—to *actuators*, which make actual physical adjustments in monitored system.

OBJECTIVE 3

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Describe the functions of various electrical/electronic test tools.

WORDS YOU SHOULD KNOW	
circuit	continuous path along a conductor through which electrical current can flow from an energy source through a load and back to the source
4EAT	four-speed electronic automatic transmission
open circuit	condition caused by a break in a circuit, causing current to stop flowing in the circuit
short circuit	condition caused when current bypasses a part of an intended circuit, causing current to flow in an accidental circuit ☑ **NOTE:** There are two types of short circuits: short-to-voltage and short-to-ground.
high-resistance circuit	condition usually caused by a loose or corroded connection, causing a reduction of current flowing in the circuit
series circuit	circuit with only one path for electricity flow from energy source through loads (and switches) and then back to energy source
parallel circuit	circuit with more than one path for electricity to flow from energy source through loads (and switches) and then back to energy source
series parallel circuit	circuit usually containing a switch connected in series; switch controls electricity flow to loads connected in parallel paths in the circuit
STAR	self-test automatic readout

- **Ammeter** — used for measuring the amount of current (amperes) in a circuit

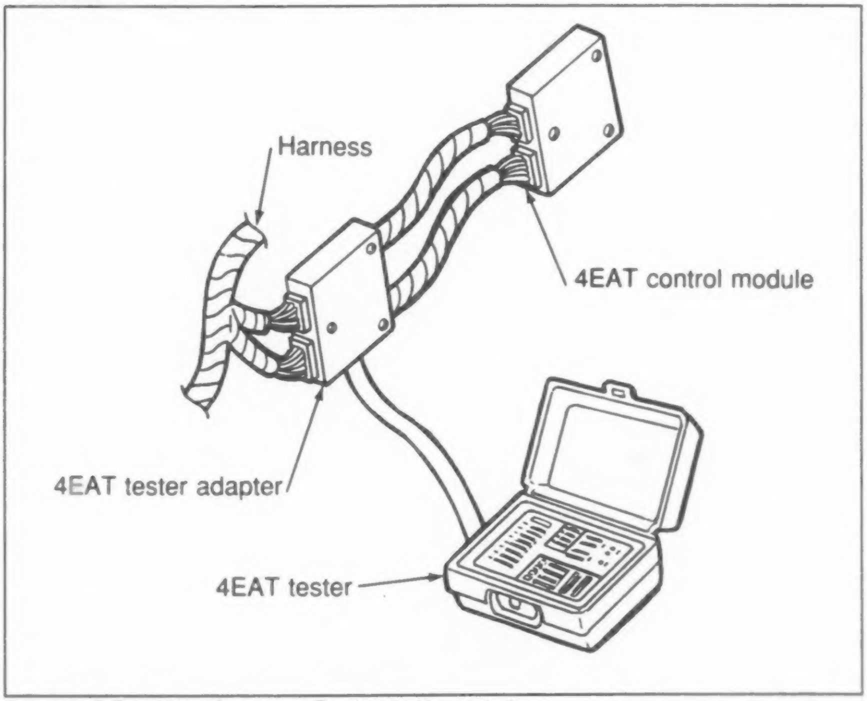
  ☑ **NOTE:** There are two types of ammeters: *conventional* and *inductive*. Conventional types must be connected in series with the circuit. Inductive types are simply slipped over the outside of the wire insulation in the circuit. The inductive ammeter uses the magnetic field around the outside of the wire to determine the amperes in the circuit.

- **Breakout box test chart** — used as a step-by-step troubleshooting reference

- **Diagnostic analyzer** — used to communicate with the ECU and to interpret data from the sensors (Figure 1)

☑ **NOTE:** Most analyzers connect directly to the vehicle's diagnostic link. Many can provide the technician with troubleshooting and repair instructions. Some analyzers provide a printout of findings.

FIGURE 1



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- **Jumper wires** — used for bypassing a portion of a circuit

- **Multimeter (VOM)** — used for measuring voltage, current, and resistance

  ☑ **NOTE:** The multimeter combines the functions of the voltmeter, ohmmeter, and ammeter into one instrument.

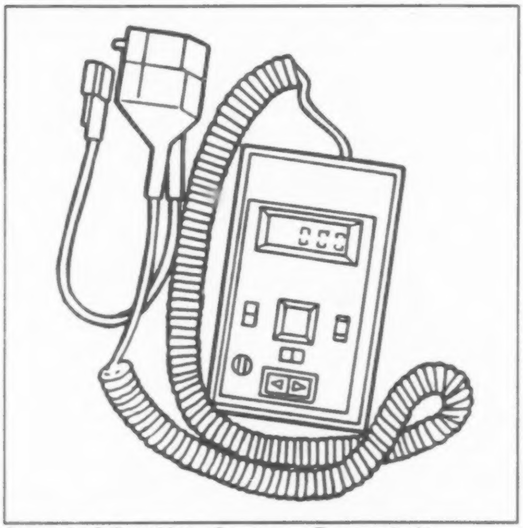
- **Ohmmeter** — used for measuring the amount of resistance (ohms) in a circuit

  ☑ **NOTE:** When an ohmmeter is used, the circuit is not powered, and the ohmmeter is connected in parallel.

- **Scan tool** — used to retrieve trouble codes; most convert the trouble code directly into a digital display (Figure 2)

  ☑ **NOTE:** Scanners cannot pinpoint problems *within the circuit.*

FIGURE 2



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- **Test light** — used for checking that voltage is present in a circuit; checking for open circuits and short circuits

  ☑ **NOTE:** There are two types of test lights: 12-volt and self-powered. Many computer circuits require the use of a high-impedance logic probe instead of a standard test light, which can cause damage to the computer.

- **Voltmeter** — used for measuring the amount of electrical pressure (voltage) in a circuit

  ☑ **NOTE:** A voltmeter is connected in parallel to a circuit, and the circuit is powered when the measurement is taken.

OBJECTIVE 4

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

State Ohm's Law.

- **Ohm's Law** — The current in an electric circuit equals the pressure (volts) divided by the resistance.

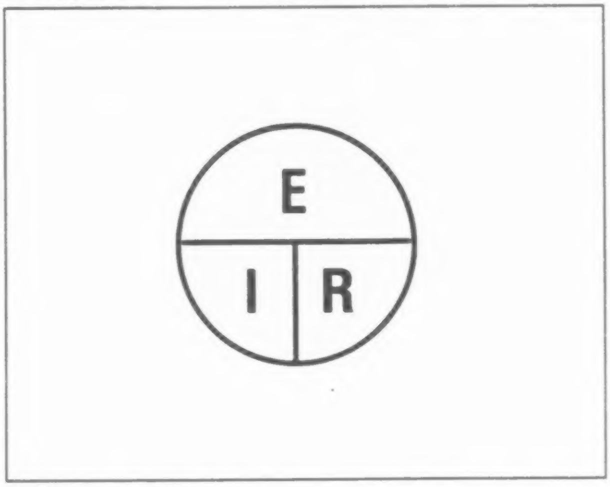
OBJECTIVE 5

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Draw Ohm's Law in wheel expression.

FIGURE 3



OBJECTIVE 6

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

List uses of Ohm's Law.

- Calculating circuit *resistance*
- Calculating circuit *amperage*
- Calculating circuit *voltage*

OBJECTIVE 7

Required Activities/
Resources in
Instructor's Guide

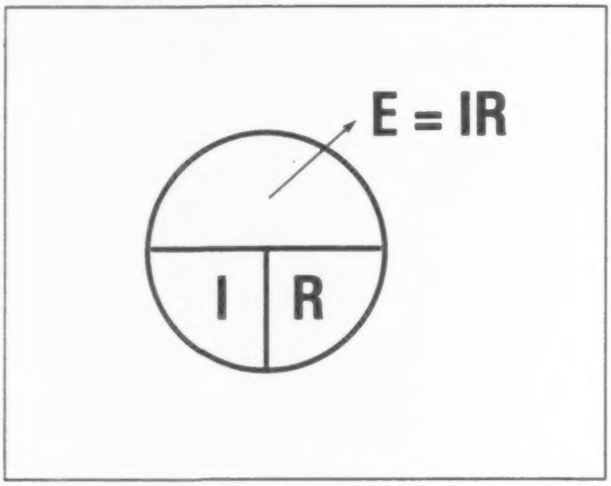
Optional Activities/
Resources in
Instructor's Guide

State the unit of measure formulas from Ohm's Law.

☑ **NOTE:** When you cover the unknown in the wheel representation of Ohm's Law, the remaining letters give you the problem-solving equation.

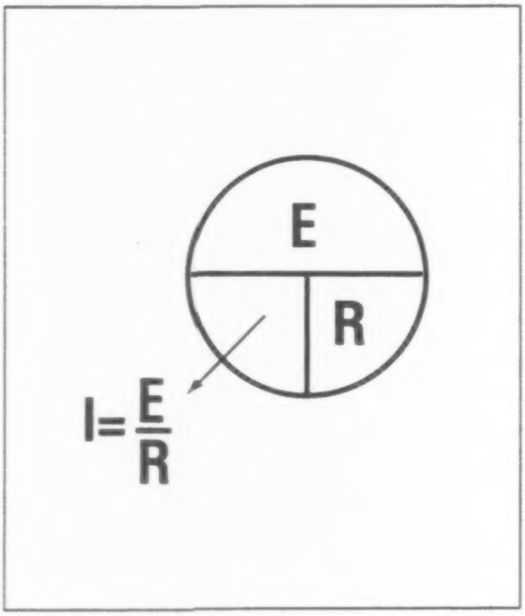
- **Formula for voltage** — Volts = Amps × Ohms or $E = I \times R$

FIGURE 4



- **Formula for amperage** — Amps = Volts ÷ Ohms or $I = E/R$

FIGURE 5



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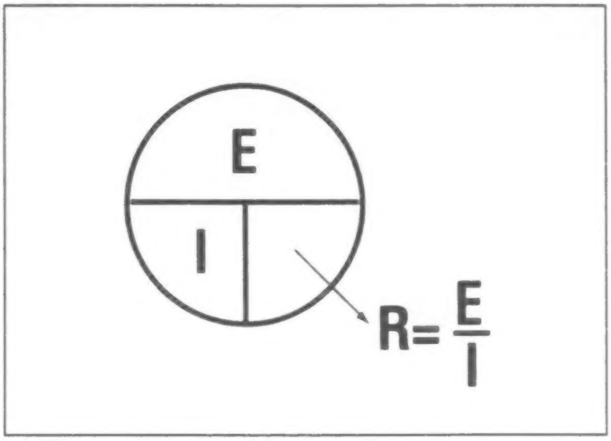
- **Formula for resistance** — Ohms = Volts ÷ Amps or R = E/I

FIGURE 6



OBJECTIVE 8

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

State Ohm's Law for power.

- **Ohm's Law for power** — The power in an electrical circuit (watts) equals the current (amperes) multiplied by the electromotive force (volts).

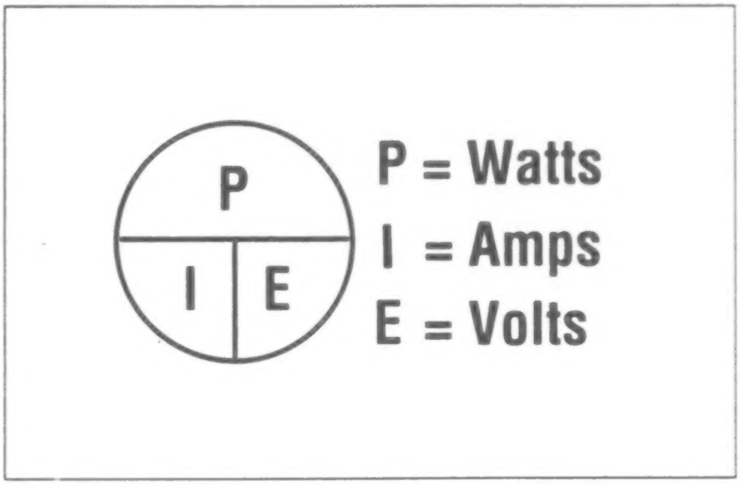
OBJECTIVE 9

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Draw Ohm's Law for power in wheel expression.

FIGURE 7



OBJECTIVE 10

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

List uses of Ohm's Law for power.

- Calculating circuit *wattage*
- Calculating circuit *voltage*
- Calculating circuit *amperage*

OBJECTIVE 11

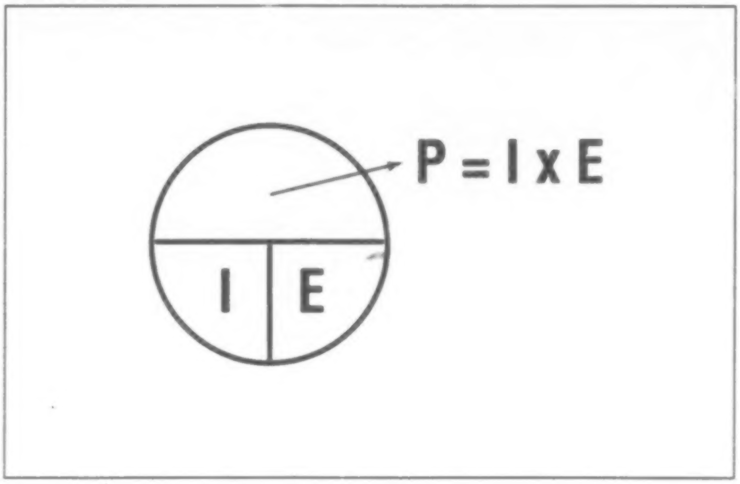
Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

State the unit of measure formulas from Ohm's Law for power.

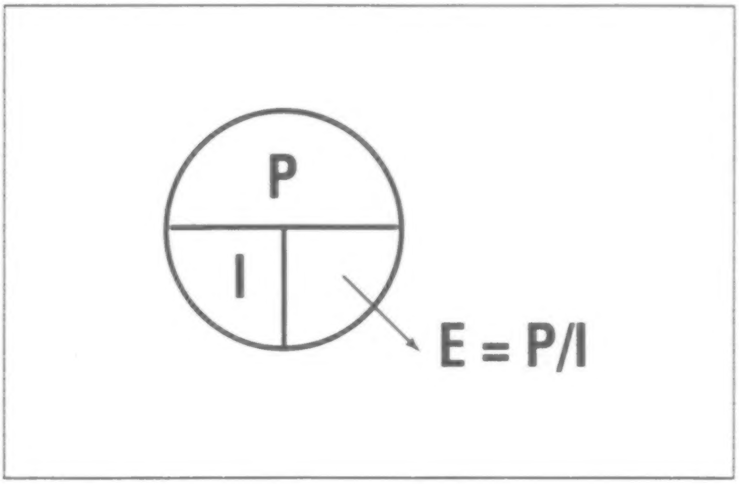
- **Formula for wattage** — Watts = Amps × Volts or P = I × E

FIGURE 8



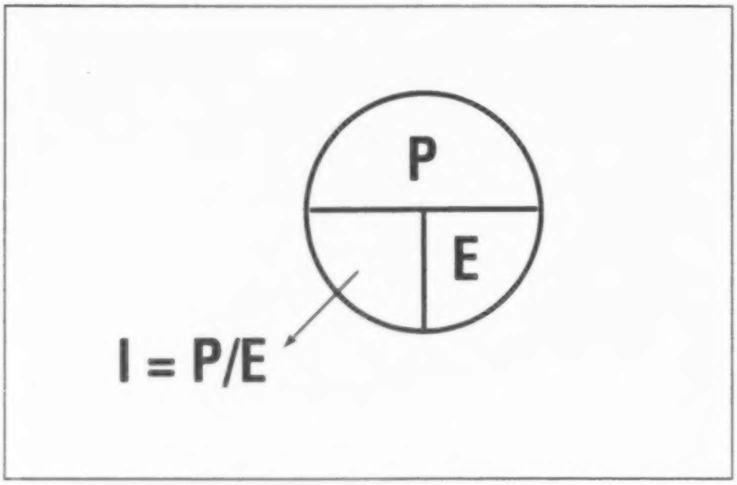
- **Formula for voltage** — Volts = Watts ÷ Amps or E = P/I

FIGURE 9



- **Formula for amperage** — Amps = Watts ÷ Volts or I = P/E

FIGURE 10



OBJECTIVE 12

Required Activities/
Resources in
Instructor's Guide

Optional Activities/
Resources in
Instructor's Guide

Describe the purposes of sensors and switches used to send the electronic control unit information for torque converter clutch operation.

- **shift solenoids** — control shift quality by controlling shift-valve operation or by directly controlling the flow of oil to the apply device
- **throttle position sensor** — sends the ECU a voltage signal indicating throttle position
- **vacuum switches (3)** — provide ECU with engine load
- **shift lever switch** — tells ECU the gear range selected (position of gear selector lever)
- **vehicle-speed sensor (VSS)** — sends vehicle-speed signals to ECU in the form of voltage pulses
- **coolant temperature sensor (CTS)** — monitors and measures coolant temperature and relays measurements to the computer

OBJECTIVE 13

Required Activities/
Resources in
Instructor's Guide

List advantages of computer control of torque converter.

- Smooth, crisp, fast, reliable shifts
- Improved fuel economy that meets government regulations

- Automatic shifts made at precisely the right moment
- Smooth response to throttle opening
- Consistent shift quality
- Engine protected by constant scanning of transmission functions
- Ensures proper lockup

OBJECTIVE 14

Optional Activities/
Resources in
Instructor's Guide

Explain how a solenoid operates a torque converter clutch.

- The TCC solenoid is located in the valve body or in the front pump, depending on the automatic transmission.
- The TCC provides a direct 1:1 mechanical coupling between the engine and the transmission.
- Electrical and electronic torque-converter clutch controls are used only with hydraulically applied converter clutches.
- The application of the clutch piston is regulated by an electric solenoid and one or more spool valves.
- The solenoid controls the pressure that signals the spool valves when to lock and unlock the TCC assembly.
- The spool valves control the various pressures that actually apply and release the clutch piston.
- In some applications, when the solenoid *is not* energized, oil pressure in the converter clutch-apply circuit passes through the solenoid check valve and is vented to the transmission sump.

☑ **NOTE:** A restricting orifice located in the apply pressure line to the TCC limits the volume of fluid flow in the apply circuit. This ensures that all fluid can be vented through the check valve and makes it impossible for the converter clutch to apply when the solenoid is not energized.

- In some applications, when the solenoid *is* energized, the check ball in the solenoid check valve seats to close off the exhaust passage, and oil pressure is directed to the spool valves that apply the TCC.

OBJECTIVE 15 **Complete Assignment Sheet 1.**

OBJECTIVES 16-19 **Complete Job Sheets 1-4.**

ASSIGNMENT SHEET 1

TESTING RELATED ELECTRONIC COMPONENTS

9

Name ______________________________ Score __________

OBJECTIVE 15

Solve problems involving Ohm's Law.

INTRODUCTION

Ohm's Law is commonly used to calculate unknown circuit resistance, wattage, amperage, and voltage. The formulas derived from Ohm's Law are readily remembered in wheel expression, and can be calculated using simple multiplication and division. This Assignment Sheet is designed to give you practice solving circuit problems involving Ohm's Law.

INSTRUCTIONS

Functional Reading
- Follow written instructions

Operation and Calculation
- Calculate with whole numbers
- Calculate with decimals
- Solve formulae and equations

Math Application
- Solve word problems
- Select/apply mathematical formula

Job Acquisition/Development
- Master specific job task/procedure

PART 1: Solve problems for unknown voltage.

Apply the appropriate formula from Ohm's Law to find voltage. Show your calculations beside each problem.

EXAMPLE 1: 2 amps, 60 ohms = ? volts
Answer: 2 × 60 = 120 volts

EXAMPLE 2: 2 amps, 240 watts = ? volts
Answer: 240 ÷ 2 = 120 volts

	Amps	Ohms		Calculations	Volts
1.	2	6	=		______
2.	.25	60	=		______
3.	2.5	2.5	=		______
4.	5	2.4	=		______

	Amps	Watts		Calculations	Volts
5.	6	72	=		________
6.	6.5	715	=		________
7.	2.5	325	=		________
8.	5	70	=		________
9.	7	88	=		________
10.	4	36	=		________

INSTRUCTIONS

PART 2: Solve problems for unknown amperage.

Apply the appropriate formula of Ohm's Law to find amperage. Show your calculations beside each problem.

EXAMPLE 1: 12 volts, 4 ohms = ? amps
Answer: 12 ÷ 4 = 3 amps

EXAMPLE 2: 120 watts, 12 volts = ? amps
Answer: 120 ÷ 12 = 10 amps

	Volts	Ohms		Calculations	Amperes
1.	12	4	=		________
2.	13	3	=		________
3.	14	5	=		________
4.	12	3	=		________
5.	14	3	=		________

	Watts	Volts		Calculations	Amperes
6.	1,800	12	=		________
7.	1,000	14	=		________
8.	500	13	=		________
9.	690	11	=		________
10.	1,200	12	=		________

INSTRUCTIONS

PART 3: Solve problems for unknown resistances and power.

Apply the appropriate formula from Ohm's Law to find unknown resistances and wattages. Show your calculations beside each problem.

EXAMPLE 1: 440 volts, 10 amps = ? ohms
Answer: 440 ÷ 10 = 44 ohms

EXAMPLE 2: 115 volts, 12 amps = ? watts
Answer: 115 × 12 = 1,380 watts

	Volts	Amps		Calculations	Ohms
1.	13.5	4	=		________
2.	14	9.6	=		________
3.	12	5	=		________
4.	11.5	5	=		________
5.	12.5	8	=		________

	Volts	Amps		Calculations	Watts
6.	12	11	=		________
7.	13.5	6	=		________
8.	11	20	=		________
9.	14	50	=		________
10.	12	0.5	=		________

INSTRUCTIONS

PART 4: Solve word problems for unknown quantities.

Apply the appropriate formula from Ohm's Law to solve the following problems. Show your calculations. Write your answers in the blanks.

EXAMPLE 1: A circuit is drawing a current of 2 amps, and the resistance is 60 Ohms. What is the voltage?

Answer: $E = I \times R$

$= 2 \times 60$

$= 120$ volts

EXAMPLE 2: What is the resistance in a circuit drawing 4 amps through a potential of 240 volts?

Answer: $R = E/I$

$= 240/4$

$= 60$ ohms

________ 1. If a 2.5-ohm circuit pulls 2.8 amperes, what is its voltage?

________ 2. A 12-volt circuit operates at 100 amperes. What is the resistance of this circuit?

________ 3. A 12-volt circuit operates at 3.5 amperes. What is the power dissipated by this circuit?

________ 4. If a circuit's power is 100 watts and the voltage is 12 volts, what is the current draw?

________ 5. How much power is produced by 14 volts at 60 amps?

________ 6. What is the resistance of the circuit in Question 5?

________ 7. At what current level will 220 volts at 10 ohms operate?

________ 8. How much power will be consumed by the circuit in Question 7?

________ 9. If 10 amperes are flowing in a 13-volt circuit, what is the circuit's total resistance?

________10. How much power is being consumed by the circuit in Question 9?

JOB SHEET 1

TESTING RELATED ELECTRONIC COMPONENTS

9

Name ______________________________

OBJECTIVE 16

Check circuit continuity with an analog ohmmeter.

INTRODUCTION

Unlike a voltmeter or ammeter, an ohmmeter provides its own electricity. Therefore, it is used for continuity testing—determining whether an electrical conductor, such as a wire or any electrical device, can conduct electricity from one point to another.

EQUIPMENT AND SUPPLIES

- Vehicle
- Ohmmeter
- Eye protection
- Appropriate service manual

PROCEDURE

Research and Reference
- Select useful resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

General Science
- Use scientific instruments

	Yes	No
1. Remove all jewelry, and put on eye protection.	____	____
2. Zero the meter, following meter manufacturer's instructions.	____	____
3. Disconnect negative (ground) cable from battery terminal.	____	____

CAUTION: The ohmmeter will be damaged if the battery ground cable is not disconnected before connecting the ohmmeter leads.

	Yes	No
4. Plug test leads into meter as directed by manufacturer's instruction manual.	____	____

Job Acquisition/ Development

- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
5. Connect test leads in parallel at circuit test location recommended by instructor or vehicle manufacturer.		
• If ohmmeter scale indicates only minor resistance, the circuit is *good.*	____	____
• If ohmmeter scale indicates high resistance, the circuit is *faulty.*	____	____
6. Disconnect ohmmeter leads from circuit, disconnecting *negative* lead *first.*	____	____
7. Reconnect negative battery cable to negative terminal.	____	____
8. Check switches and grounds in same manner.	____	____

☑ **NOTE:** You must make a zero-ohms adjustment each time you move the range-selector switch to a new resistance position.

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1

Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

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JOB SHEET 2

TESTING RELATED ELECTRONIC COMPONENTS

9

Name ______________________________

OBJECTIVE 17

Measure current, voltage, and resistance with a digital multimeter (DVOM).

INTRODUCTION

To measure current, voltage, or resistance in a vehicle circuit, the specialist may use individual pieces of equipment (as in Job Sheet 1) or may choose to use a *multimeter*, a test instrument that combines these three individual meters in one case with a function knob that can be turned to select the type of measurement made.

⚠ **CAUTION:** Whenever you use a multimeter in any function, handle it with great care. It is a delicate instrument and can be damaged by being dropped or knocked about when used in the shop or when taken into the field for service jobs.

EQUIPMENT AND SUPPLIES

- Digital multimeter
- Multimeter manufacturer's instruction manual
- Vehicle circuit
- Appropriate service manual

PROCEDURE

Measure circuit current (amperage). Yes No

☑ **NOTE:** Your instructor will tell you what circuit to test.

Research and Reference
- Select useful resources
- Use standard references
- Use in-book reference tools

1. Check service manual for wiring diagram of circuit under test to determine
   - range of circuit under test; ___ ___

     ☑ **NOTE:** This information is not always given in a wiring diagram.

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

General Science
- Use scientific instruments

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

	Yes	No
• procedure for opening circuit under test; and	____	____
• best test location for circuit under test (where to attach meter in circuit).	____	____
2. Check meter manufacturer's instruction manual to determine		
• proper meter setting for measuring amperage in circuit under test; and	____	____
NOTE: Most hand-held meters are capable of measurements in the 10-amp range. You may have to obtain a special shunted meter, such as a VAT-40, for certain vehicle circuits.		
• procedure for plugging test probes into meter for measuring amperage.	____	____
3. Open circuit under test as directed in service manual.	____	____
4. Plug test probes into meter as directed in meter manufacturer's instruction manual.	____	____
5. If the service manual wiring diagram lists range of circuit under test, set meter range-selector switch to specified position.	____	____
6. If service manual wiring diagram does not list range of circuit under test (you are working with unknown currents), set range-selector switch on highest reading.	____	____

⚠ **CAUTION:** Setting the meter too low could damage the meter.

	Yes	No
7. Attach test probes in series at circuit test location determined in Step 1.	____	____
8. If you are unable to get a meter reading, position the range-selector switch at progressively lower settings until a reading is displayed.	____	____

Yes No

9. If the meter reads backwards, reverse the probes and take another reading. ____ ____

   ☑ **NOTE:** If the meter is reading backwards, the display will show a *negative* reading.

10. Record (below) reading when obtained. ____ ____

    Circuit ____ amperage = ____________________

PROCEDURE

Measure circuit voltage (volts).

1. Check service manual for wiring diagram of circuit under test to determine
   - range of circuit under test; ____ ____

     ☑ **NOTE:** This information is not always given in a wiring diagram.

   - procedure for opening circuit under test; and ____ ____
   - best test location for circuit under test (where to attach meter in circuit). ____ ____
2. Check meter manufacturer's instruction manual to determine
   - proper meter setting for measuring voltage in circuit under test; and ____ ____
   - procedure for plugging test probes into meter for measuring voltage. ____ ____
3. Open circuit under test as directed in service manual. ____ ____
4. Plug test probes into meter as directed in meter manufacturer's instruction manual. ____ ____
5. If the service manual wiring diagram lists range of circuit under test, set meter range-selector switch to specified position. ____ ____

Yes No

6. If service manual wiring diagram does not list range of circuit under test, set meter range-selector switch at a position slightly greater than 12 volts. ____ ____

   ☑ **NOTE:** Since most vehicle electrical systems operate on 12 volts, setting the switch at a setting slightly higher than 12 volts will protect the meter from damage.

7. Attach test probes in parallel at circuit test location determined in Step 1. ____ ____

8. If you are unable to get a meter reading, position range-selector switch at progressively lower settings until reading is displayed. ____ ____

9. If meter reads backwards, reverse probes and take another reading. ____ ____

   ☑ **NOTE:** If the meter is reading backwards, the display will show a *negative* reading.

10. Record (below) reading when obtained. ____ ____

    Circuit ____ voltage = ____________________

PROCEDURE

Measure circuit resistance (ohms).

1. Check service manual for wiring diagram of circuit under test to determine
   - range of circuit under test; ____ ____

     ☑ **NOTE:** This information is not always given in a wiring diagram.

   - power source for circuit under test; ____ ____
   - procedure for opening circuit under test; and ____ ____
   - best test location for circuit under test (where to attach meter in circuit). ____ ____

	Yes	No
2. Check meter manufacturer's instruction manual to determine		
• procedure for zeroing meter for ohms reading;	____	____
• proper meter setting for measuring ohms in circuit under test; and	____	____
• procedure for plugging test probes into meter for measuring ohms in circuit under test.	____	____
3. Zero the meter, following manufacturer's instructions.	____	____

☑ **NOTE:** You must make a zero-ohms adjustment each time you move the range-selector switch to a new resistance position.

	Yes	No
4. Turn off power to circuit under test.	____	____

⚠ **CAUTION:** When working with an ohmmeter, the power must be off in the circuit under test. Damage to the meter will result if the circuit is powered.

	Yes	No
5. Open circuit under test.	____	____
6. Plug test probes into meter as directed in manufacturer's instruction manual.	____	____
7. If service manual wiring diagram lists range of circuit under test, set range-selector switch to the correct position for circuit.	____	____
8. If service manual wiring diagram does not list range of circuit under test, set meter range-selector on lowest setting.	____	____
9. Attach test probes in parallel at circuit test location determined in Step 1.	____	____
10. If you are unable to get a meter reading, position range-selector switch at progressively higher settings until a reading is displayed.	____	____

	Yes	No
11. Record (below) reading when obtained.	____	____

Circuit ____ ohms = ____________________

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING	**Evaluator note:** To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.
KEY	4 **Skilled** — Can perform job with no additional training. 3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required. 2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill. 1 **Unskilled** — Is familiar with process, but is unable to perform job.
EVALUATOR'S COMMENTS	____ ____ ____

JOB SHEET 3

TESTING RELATED ELECTRONIC COMPONENTS

Name ______________________________

OBJECTIVE 18 **Test transmission/transaxle-related electrical/electronic components.**

INTRODUCTION

Electronics has become an integral part of many modern vehicles. Because of this, today's automatic transmission/transaxle specialists must learn how to check for and read computer codes. Reading most codes involves diagnosing a circuit with a scan tool and referencing applicable electrical/electronic troubleshooting charts and wiring diagrams.

Wiring problems should always be suspected when an open circuit or a faulty sensor is indicated by trouble codes. Electronic service usually consists of testing the suspected sensor or component and replacing the item if it is faulty.

Guidelines

- Because today's electronic computer components are *solid-state*, they have no moving parts and last for a long time. Thus, most computer problems are caused by loose or faulty electrical connections, leaking vacuums, or physical damage.

- The first step in pinpointing a computer control system problem is to *visually inspect* the suspect circuits and all related components.

- Check vacuum hoses for cracks and restrictions. Examine hose for proper connections. Improper hose routing can upset the operation of a computer-controlled system.

- Refer to manufacturer's service manual for the location of transmission/transaxle electrical connectors. Check electrical connections for signs of *oxidation* and *misalignment*.

- Clean any corrosion from connections with sandpaper or a small file. Spray the connections with a light lubricant spray, such as dielectric grease. Poor or nonconductive electrical connections prevent solenoids within the transmission/transaxle from working properly.

- Use scanning tool to retrieve trouble codes from sensors and determine the circuit or area that is operating improperly. Once the trouble code has been obtained, perform the *pinpoint tests* indicated on the breakout box troubleshooting chart to locate the faulty component(s) within the circuit.

- *Never* conduct tests on electronic and computerized equipment without consulting the appropriate service manual. *Improper testing methods can destroy a sensor.*

- When diagnosing trouble codes and circuits, wiggle the harness and/or connectors while monitoring circuits. This procedure will help you pinpoint an open circuit, an area of high resistance, or the causes of intermittent conditions.

- Use an ohmmeter or multimeter to check the operation of signal-modifying sensors (to verify the sensor's internal resistance). Compare all measured values with service manual specifications.

- Use a voltmeter or multimeter to test the output of signal-producing sensors. Compare all measured values with service manual specifications.

- Work *safely*. Remove all rings or jewelry before working on any part of the electrical system. Avoid touching grounding tools to powered electrical leads or connections. Such accidental connections can result in severe burns or dangerous sparks, which, in turn, can cause an explosion if gasoline or volatile solvents are present.

- Follow the following guidelines when testing circuit wiring:

    - ☐ Check circuit wiring with a standard ohmmeter.

    - ☐ Disconnect the wire at both ends of the circuit.

    - ☐ Attach one end of the wire to a ground.

    - ☐ Attach meter lead to ungrounded end of the wire and the other lead to a common ground.

    - ☐ If measured resistance is greater than service manual specifications, replace the wiring.

- Follow the following guidelines when testing for short circuit:

    - ☐ Connect ohmmeter to one end of the wire in question and the other lead to a good ground.

☐ If there is very low or no resistance, the wire may be shorting to ground; if the ohmmeter shows infinite, the circuit is not grounded.

EQUIPMENT AND SUPPLIES

- Vehicle
- Hoist
- Eye protection
- Basic hand tool set
- Digital voltmeter

☑ **NOTE:** Always use a digital voltmeter on electronic circuits.

- Ohmmeter
- 10-megohm impedence logic probe
- Jumper wire
- Electronic diagnostic tester
- Scan tool
- Manufacturer's approved lubricant spray (dielectric grease)
- Applicable electrical troubleshooting manual or wiring diagram
- Other equipment and materials as required by procedure
- Appropriate service manual

PROCEDURE

Research and Reference
- Select useful resources
- Use standard references
- Use in-book reference tools

Functional Reading
- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

☑ **NOTE:** Refer to appropriate service manual for make and model as equipped. Follow the procedure in the service manual.

Process Evaluation Criteria:

	Yes	No
1. Consulted the service manual.	____	____
2. Followed all procedures in order as listed in the service manual.	____	____
3. Worked safely.	____	____
4. Used ohmmeter and voltmeter appropriately, and compared all measured values with service manual manufacturer's specifications.	____	____
5. Used scan tool to test electronic components; and correctly interpreted trouble codes.	____	____

	Yes	No
6. Referred to applicable electrical troubleshooting manual or wiring diagram.	____	____
7. Replaced defective wiring and components according to service manual instructions and using approved materials.	____	____

General Science
- Use scientific instruments

Job Acquisition/Development
- Master specific job task/procedure
- Practice good work habits/attitudes

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

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JOB SHEET 4

TESTING RELATED ELECTRONIC COMPONENTS

9

Name ____

OBJECTIVE 19

Perform computer relearn procedures.

INTRODUCTION

Vehicles equipped with engine or transmission computers may require a relearn procedure after the vehicle battery is disconnected. Many vehicle computers memorize and store vehicle operation patterns. When the battery is disconnected, this memory is lost. The computer uses default data until new data from each key start is stored. As the computer memorizes vehicle operation for each new key start, driveability is restored. Vehicle computers may memorize operation patterns for 40 or more key starts.

During the time that the computer is rememorizing data (relearning stage), customers may complain of driveability problems because the vehicle acts differently than before it was serviced. Customers may complain of the following problems:

- Harsh or poor shift quality
- Rough or unstable idle
- Hesitation or stumble
- Rich or lean fuel running
- Poor fuel mileage

These symptoms should disappear after a number of drive cycles have been memorized. However, to reduce the possibility of complaints, *perform the following relearn procedures after any service that requires battery power to be disconnected.*

The procedure below is a general relearn procedure for all vehicles. However, some manufacturers identify specific relearn procedures for resetting shift quality, idle, throttle position sensors, and other computer-controlled components that help establish suitable driveability. These procedures are especially important if the vehicle is equipped with an electronically-controlled automatic transmission or transaxle. Always consult the appropriate service manual and complete the procedure before returning the vehicle to the customer.

EQUIPMENT AND SUPPLIES

- Vehicle

PROCEDURE

Functional Reading
- Follow written instructions

Job Acquisition/ Development
- Master specific job task/procedure
- Practice good work habits/attitudes

CAUTION: Follow all safety precautions and safe driving procedures used for normal road testing of any vehicle.

	Yes	No
1. Fasten your seatbelt.	____	____
2. Adjust mirrors and seat.	____	____
3. Familiarize yourself with the vehicle's operating controls.	____	____
4. Set parking brake.	____	____
5. Start engine in *park* or *neutral* position.	____	____
6. Warm vehicle to normal operating temperature or until cooling fan cycles.	____	____
7. Allow vehicle to idle for 1 minute with gearshift selector in *neutral* (N) position.	____	____
8. Move gearshift lever to *drive* (D) position and allow vehicle to idle for 1 minute.	____	____
9. Accelerate at normal throttle position (20% to 50%) until vehicle shifts into top gear.	____	____
10. Cruise at light to medium throttle.	____	____
11. Decelerate to a stop, using brakes normally, and allowing vehicle to downshift.	____	____
12. Repeat process as necessary.	____	____

SKILL TEST RECORD

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training.
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required.
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill.
1 **Unskilled** — Is familiar with process, but is unable to perform job.

EVALUATOR'S COMMENTS

AUTOMATIC TRANSMISSION/TRANSAXLE SPECIALIST

CIMC

READING SKILLS

UNITS OF INSTRUCTION	Reading Comprehension									Research and Reference								Functional Reading						Language		Composi				
	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques	Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers	Interpret forms and records	Follow written instructions	Interpret graphics and symbols	Use content area vocabulary	Interpret abbreviations/acronyms	Read aloud	Use standard grammar and correct spelling, punctuation, and capitalization	State ideas clearly	Use complete sentences	Develop preliminary outline	Use topic sentences	Use introductory/closing paragraphs	Compose reports
Intro to Automatic Transmission/Transaxles	●				●	●																		●	●	●				
Servicing Hydraulic System Components	●				●	●					●		●	●					●		●			●	●	●				
Servicing Rear-Wheel Drive Transmissions	●									●			●	●					●	●	●			●	●	●				
Servicing Torque Converter and Oil Pump	●				●	●							●	●					●	●	●			●	●	●				
Servicing Gear Train/Gearsets	●				●	●							●	●					●	●	●			●	●	●				
Servicing Friction Units and Cooler	●				●	●							●	●					●	●	●			●	●	●				
Servicing Front-Wheel Drive Transaxles	●				●	●					●		●	●					●	●	●			●	●	●				
Diagnosing General Automatic Transmission Transaxle Problems	●				●	●							●	●					●	●	●	●		●	●	●				
Testing Related Electronic Components	●				●	●				●			●	●					●	●	●			●	●	●				

CIMC BASIC SKILLS DOCUMENTATION

WRITING SKILLS

MATH SKILLS

position					Research					Functional Writing							Operation and Calculation														Math Application											Data Analysis and Display							
Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit	Construct graphics and symbols	Take notes	Use notecards	Create bibliography	Use footnotes	Outline material	Complete forms and records	Write instructions	Write letters	Write job applications	Write resumes	Use word processing	Use computer graphics	Round off numbers	Estimate answers	Use scientific notations	Use exponential notations	Calculate with whole numbers	Calculate with fractions	Calculate with decimals	Convert whole numbers to fractions	Convert whole numbers to decimals	Solve numerical expressions	Solve formulae and equations	Obtain squares and square roots	Convert units of measure	Perform metric calculations	Solve word problems	Select/apply mathematical formula	Select/apply mathematical procedure	Use English and metric measures	Solve time/rate/distance problems	Solve ratio/proportion problems	Solve percent problems	Apply techniques of scaling	Apply algebra principles	Apply geometry principles	Apply trigonometry principles	Interpret charts and tables	Interpret graphs (type)	Collect /record data	Apply sampling techniques	Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics
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N MATRIX

S

SCIENCE SKILLS

95-011036

sis y				Functional Math														General Science									Life Science							Physical Science					Earth Science							
Construct graphs	Calculate statistics	Interpret statistics	Interpret blueprints/plans	Make measurements	Perform banking transactions	Make change	Solve practical problems	Calculate gross earnings	Solve income/expense problems	Prepare a budget	Calculate interest	Solve interest problems	Calculate sales tax	Determine income tax	Use calculator for computation	Use computer for computation	Use computer spreadsheets	Apply computing skills	Apply scientific method of inquiry	Conduct experiments	Investigate science ethics	Investigate science history	Investigate/apply economics in technology	Use scientific instruments	Investigate/apply technology	Collect specimens	Identify/classify living organisms	Investigate biological history of the earth	Investigate food chains, webs, pyramids	Investigate/apply principles of human development	Investigate/apply principles of genetics/heredity	Investigate/apply principles of anatomy/physiology	Investigate health issues	Analyze/classify matter	Investigate forms/changes of matter	Investigate forms/changes of energy	Investigate/apply chemical properties	Investigate/apply physical laws	Investigate physical characteristics of the earth	Investigate geological history of the earth	Investigate physical forces acting on the earth	Solve problems of longitude, latitude, and time zones	Investigate conservation of physical resources	Investigate conservation of living resources	Investigate issues of environmental impact	Apply science principles to environmental issues
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CIMC

ORAL COMMUNICATION SKILLS

IN

UNITS OF INSTRUCTION	Oral Presentation									Listening				Interactive Communication										General Relating											
	Make informative presentations	Make persuasive presentations	Present personal opinion/viewpoint	Use good speaking techniques	Select/use words effectively	Use effective body language	Present appropriate appearance	Integrate audio and/or visual materials in oral presentations	Adapt presentation to specific audience	Apply active listening skills	Distinguish fact, opinion, and inference	Draw conclusions/make generalizations	Analyze/identify point of view	Give/follow oral directions	Apply questioning techniques	Conduct/receive interviews	Analyze/apply nonverbal communication	Work effectively in a group	Communicate with clients/customers/patients	Communicate with co-workers	Communicate with supervisors	Communicate with professional colleagues/associates	Apply telephone etiquette	Investigate/apply communication process models	Analyze/apply nonverbal communication	Investigate/apply cross-cultural communication	Interact with co-workers	Interact with supervisors	Interact with clients/customers/patients	Interact with professionalcolleagues/associates	Interact with family/friends	Participate in group activities	Participatein industrial relations/functions	Identify personal values/attitudes	Apply information to life experiences
Intro to Automatic Transmission/Transaxles																																			
Servicing Hydraulic System Components																																			
Servicing Rear-Wheel Drive Transmissions																																			
Servicing Torque Converter and Oil Pump																																			
Servicing Gear Train/Gearsets																																			
Servicing Friction Units and Cooler																																			
Servicing Front-Wheel Drive Transaxles																																			
Diagnosing General Automatic Transmission Transaxle Problems																																			
Testing Related Electronic Components																																			
* Use this line for entering your state or local codes for graduation requirements or learner outcomes.																																			

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INTERPERSONAL OR RELATING SKILLS																									CREATIVE THINKING/ PROBLEM SOLVING SKILLS																				EMPI						
			Teamwork/ Cooperation															Leadership/ Influence							Cognitive Activities																				Job Search/ Selection						
Participate in industrial relations/functions	Identify personal values/attitudes	Apply information to life experiences	Identify values/attitudes	Identify needs/drives	Select/apply appropriate behavior	Investigate/identify personal styles	Investigate/identify group/corporate climate	Give/receive feedback	Identify hidden purposes	Investigate/apply group dynamics	Control undesirable/inappropriate behavior	Resolve conflicts	Clarify goals/objectives	Devise "win/win" situations	Build consensus	Generate ideas	Present point of view	Analyze/apply leadership styles	Analyze/apply management styles	Obtain confidence of others	Develop esteem in self/others	Persuade others	Analyze/apply motivation techniques	Provide positive coaching	Collect/record information	Identify critical elements/issues	Define a problem	Identify underlying causes	Apply a problem-solving model	Analyze/synthesize information	Identify/analyze underlying assumptions	Draw conclusions	Predict results/outcomes	Identify/evaluate consequences	Identify/develop alternatives	Evaluate alternatives	Select an alternative	Devise a solution	Create a finished product	Apply intuitive/creative thinking processes	Transfer knowledge/training to new situations	Apply new technology	Develop an action plan	Evaluate results/outcomes	Analyze personal occupational aptitudes/preferences	Investigate employment prospects of a career field/occupation	Investigate training requirements for a career field/occupation	Investigate benefits of a career field/occupation	Compare/evaluate career options	Develop personal career path	Locate appropriate jobs
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Best Competency-Based Instructional Systems for Vocational Educ

MPLOYABILITY SKILLS

SOCIAL STUDIES SKILLS

				Job Aquisition/ Development														Information Analysis						Social Studies Application										Functional Social Studies														
Compare/evaluate career options	Develop personal career path	Locate appropriate jobs	Analyze duties/requirements/benefits of specific job	Master specific job task/procedure	Fill in job-related application	Write letter of application	Write personal resume	Interview for a job	Apply business etiquette	Practice good work habits/attitudes	Develop good personal presentation	Develop self-confidence/esteem	Develop effective leadership	Deal effectively with supervisors	Deal effectively with co-workers	Deal effectively with professional colleagues/associates	Deal effectively with customers/clients	Collect/record data	Interpret graphical information	Construct graphical information	Interpret maps/globes	Interpret statistical information	Analyze/interpret demographic information	Investigate/apply U.S. history	Investigate/apply world history	Investigate/apply U.S. geography	Investigate/apply world geography	Investigate/apply principles of government/politics	Investigate/apply principles of economics	Investigate/apply principles of ethics	Investigate/apply principles of psychology	Investigate/apply principles of sociology	Investigate/apply cross-cultural studies	Practice responsible personal economics	Prepare a personal budget	Use credit responsibly	Practice good work ethics	Participate in industrial relations	Interact with people of different races/cultures	Investigate/participate in government	Investigate/apply American legal practices	Select/use sources of information on current events	Analyze current events	Analyze consumer issues	Analyze social issues	Analyze conservation/ecology issues	Analyze social impact of science/technology	Analyze economic impact of science/technology
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